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Additions to Pacific Slope Turonian Gastropoda

by

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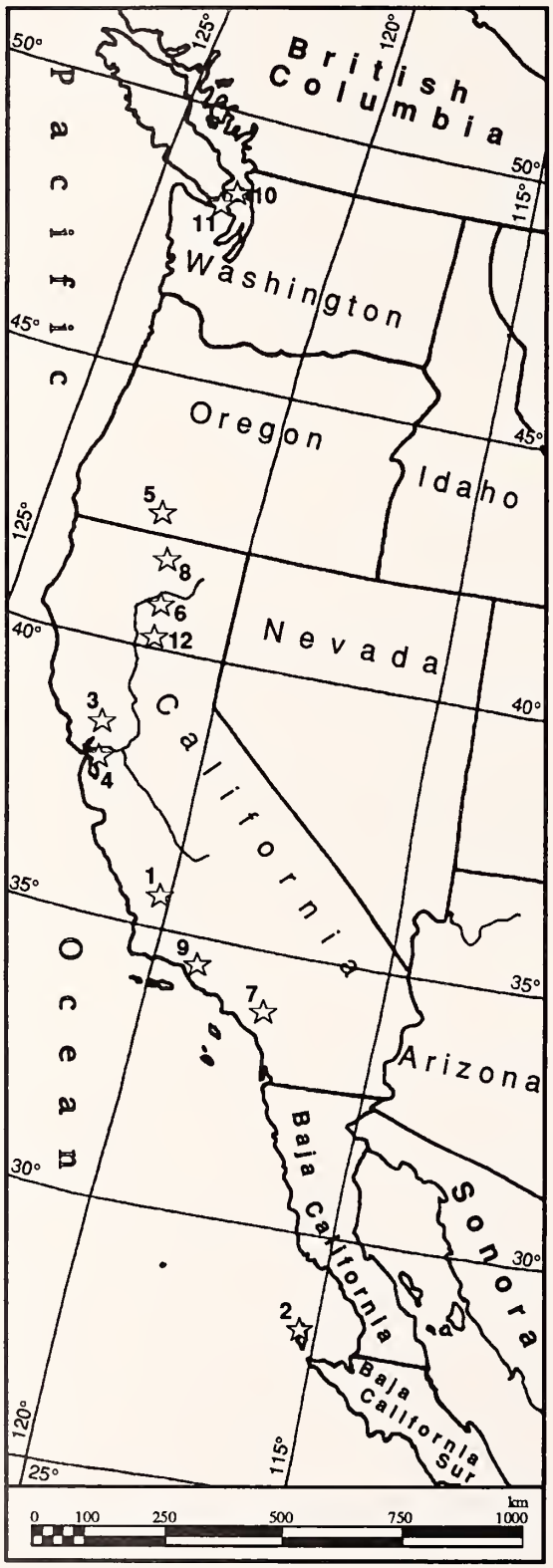
Abstract. Eighteen species of Pacific Slope Turonian (Late Cretaceous) gastropods are discussed. Nine of the species and six of the genera are new. The new genera are ***Praesargana***, ***Cydas***, ***Saturnus***, ***Skyles***, ***Varens***, and ***Konistra***. The new species are *Anchura* (*Helicaulax*) ***tricosa***, *Confusiscala?* ***juvenca***, *Confusiscala?* ***sulfurea***, *Eripachya* ***vaccina***, *Drilluta* ***sicca***, ***Skyles salsus***, *Remera* ***vacca***, ***Varens anae***, and ***Varens formosus***. The Turonian age of *Palaeatractus crassus* Gabb, 1869, and ***Saturnus*** *dubius* (Packard, 1922) is demonstrated. Supraspecific assignment, age, and geographic distribution of *Anchura* (*Helicaulax*) *condoniana* (Anderson, 1902), *Praesargana condoni* (White, 1889), *Cydas crossi* (Anderson, 1958), *Drilluta jacksonensis* (Anderson, 1958), *Carota dilleri* (White, 1889), *Carota? mitraeformis* (Gabb, 1869), and *Konistra biconica* (Anderson, 1958) are discussed. Recognition of Gulf Coast and Western Interior genera *Drilluta, Remera,* and *Carota* for the first time in Pacific Slope faunas adds to the probability of greater interchange than previously recognized between the Gulf Coast-Western Interior and the Pacific Slope during the Turonian.

INTRODUCTION

Pacific Slope molluscan faunas of Cretaceous age remain underdescribed. W. P. Popenoe worked on the rich Cretaceous fauna of the Redding area, Shasta County, California (Figure 1), for roughly 50 years. He was particularly interested in gastropods of Turonian age and left at his death unpublished descriptions of a number of species. This paper describes or discusses 18 species, nine of which are new, and proposes six new genera. Although these descriptions are from an uncompleted manuscript on the Redding area, not all of the specimens discussed are from there. Figure 1 is an orientation map for places of occurrence. New taxa proposed are: *Anchura* (*Helicaulax*) ***tricosa*** sp. nov., *Confusiscala?* ***juvenca*** sp. nov., *Confusiscala?* ***sulfurea*** sp. nov., ***Praesargana*** *condoni* (White, 1889) gen. nov., ***Cydas*** *crossi* (Anderson, 1958) gen. nov., *Eripachya* ***vaccinus*** sp. nov., ***Saturnus*** *dubius* (Packard, 1922) gen. nov., *Drilluta* ***sicca*** sp. nov., ***Skyles salsus*** gen. et sp. nov., *Remera* ***vacca*** sp. nov., ***Varens anae*** gen. et sp. nov., ***Varens formosus*** gen. et sp. nov., and ***Konistra*** *biconica* (Anderson, 1958) gen. nov. Systematic and stratigraphic position and geographic distribution are discussed for *Anchura* (*Helicaulax*) *condoniana* Anderson, 1902, *Palaeatractus crassus* Gabb, 1869, *Drilluta jacksonensis* (Anderson, 1958), *Carota dilleri* (White, 1889), and *Carota? mitraeformis* (Gabb, 1869). *Palaeatractus crassus* Gabb, 1869, "*Cordiera*" *mitraeformis* Gabb, 1869, *Acteon politus* Gabb, 1869, and *Liocium punctatum* Gabb, 1869, were originally described "From the Shasta Group, from a canyon in the foothills, a mile south of the road from Colusa to the Sulphur Springs near the eastern margin of the Coast Range, Colusa County," and considered by Gabb (1869) to be of Early Cretaceous age. All four have, however, been collected from beds of Turonian age in the Redding Formation.

Pacific Slope Cretaceous gastropod faunas show, in general, little similarity to faunas of the Gulf Coast and Western Interior, but generic affinities of the Pacific Slope Senonian gastropods to those of Japan have commonly been

[1] Deceased.



recognized. However, among the 13 Turonian genera discussed in this paper, four are also present in the Gulf Coast-Western Interior and a fifth, ***Praesargana,*** bears strong resemblance to a Gulf Coast genus. These gastropods thus suggest greater interchange with Atlantic realm faunas during the Turonian than during the Senonian. Quantitative comparisons of these faunas must await more complete description of the Pacific Slope faunas. In addition to increasing the knowledge of the paleogeographic distributions of some groups, the descriptions of these Turonian forms increase our ability to assess biodiversity of the past.

Curatorial abbreviations used are CASG = California Academy of Sciences, Geology; CIT = California Institute of Technology; CSMB = California State Mining Bureau; GSC = Geological Survey of Canada; LACM = Natural History Museum of Los Angeles County, Malacology Section; LACMIP = Natural History Museum of Los Angeles County, Invertebrate Paleontology Section; MCZ = Harvard University, Museum of Comparative Zoology; UCBMP = University of California, Berkeley, Museum of Paleontology; UCLA = University of California, Los Angeles, Department of Earth and Space Sciences; UCR = University of California, Riverside, Department of Geological Sciences; USGS = United States Geological Survey; USNM = United States National Museum; UW = University of Washington, Thomas Burke Museum.

In the following descriptions, species characterized as small are under 20 mm in height; those characterized as medium-sized range between 20 mm and 60 mm in height; and those characterized as large are 60 mm or more in height.

Features measured are listed by the following abbreviations in tables: height = H; maximum diameter = D; height of penultimate whorl = Hp; diameter of penultimate whorl = Dp; height of spire = Ha; height of shoulder on penultimate whorl = Hs; length of extended outer lip in aporrhaids = Lw; length of prong in aporrhaids = Lp;

←

Figure 1

Index map. Two sequences have provided the bulk of the studied material: the exposures of the Redding Formation, northeast of Redding, Shasta Co., and the lower part of the Ladd Formation in the northern Santa Ana Mountains, Orange Co., California. A third significant unit is the Osburger Gulch Member of the Hornbrook Formation cropping out in Jackson Co., Oregon, and Siskiyou Co., California. Place names (starred) mentioned in the text are: 1, Antelope Valley, Kern. Co., California; 2, Cedros Island, Baja California, Mexico; 3, Colusa to the Sulphur Springs, Colusa Co., California; 4, Martinez, Contra Costa Co., California; 5, Phoenix, Jackson Co., Oregon; 6, Redding, Shasta Co., California; 7, Santa Ana Mts., Orange Co., California; 8, Siskiyou Co., California; 9, Simi Hills, Los Angeles Co., California; 10, Sucia Island, San Juan Co., Washington; 11, Sydney Island, Straits of Georgia, British Columbia; 12, Tuscan Springs, Tehama Co., California.

length of aperture = La; length of rostrum = Lr; pleural angle = A; number of axial ribs per whorl = R.

SYSTEMATIC PALEONTOLOGY

Phylum Mollusca Linnaeus, 1758

Class Gastropoda Cuvier, 1797

Order Mesogastropoda Wenz, 1938

Superfamily Strombacea Rafinesque, 1815

Family APORRHAIDAE Gray, 1850

Aporrhaids have an aperture with at least three large sinus areas that are independent of the lip extensions. One is posterior and adjacent to the whorl, the second bends the outer lip next to the rostrum, and the third is a hollow across the base of the columella and whorl base that exits on the body side of the anterior rostrum. When the animal is in living position, these sinuses accommodate the head and foot of the animal beneath the shell (Figure 2). The depth of the basal sinus (Figure 2C) is accentuated in some aporrhaids by the buildup of callus on the apertural face of the last whorl. In Campanian and Maastrichtian *Anchura* spp. these calluses are commonly very thick, but in the Turonian *Helicaulax* spp. the inner lip is thin to thick and not expanded onto the face of the last whorl.

Genus *Anchura* Conrad, 1860

Type species: *Anchura abrupta* Conrad, 1860, by monotypy, from the Gulf Coast Maastrichtian.

Diagnosis: Medium- to large-sized aporrhaids with high, evenly tapering spires; sculpture ornate, with both axial and spiral elements, commonly noded at intersections; aperture sublenticular; anterior rostrum long and narrow; outer lip elongate, extended into a falcate digitation, bent posteriorly.

Subgenus *Anchura* Conrad, 1860

Diagnosis: *Anchura* with the long narrow anterior rostrum deflected to the left in apertural view; lateral arm of the outer lip without flanges.

Discussion: Time and geographic ranges of the subgenus *Anchura* are difficult to determine in the absence of more complete studies of various species that have been assigned to it (SOHL, 1960). The subgenus is well represented in beds ranging in age from Cenomanian through Maastrichtian of North America and Europe. It appears to have a longer range and be more prolific in the Western Interior and the Gulf Coast than elsewhere. On the Pacific Slope it has not yet been found earlier than Turonian. Two Pacific Slope species have been described, *Anchura* (*Anchura*) *falciformis* (Gabb, 1864) of early Campanian age and *A.* (*A.*) *gibbera* Webster, 1983, of early Maastrichtian age. Although "*Anchura*" *angulata* (Gabb, 1864) of ?Albian–Cenomanian age resembles *Anchura* in overall shape, it has a wing more like that of *Drepanochilus* Meek, 1864, or *Dimorphosoma* Gardner, 1875, and very fine sculpture on the spire that is distinctly different than the ornate sculpture of typical *Anchura*.

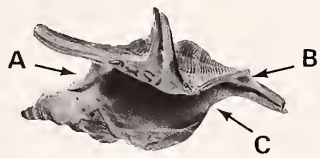


Figure 2

Three large sinus areas of the aporrhaid aperture. A. Posterior sinus to accommodate the posterior part of the foot. B. Anterior outer lip sinus to accommodate the snout. C. Basal sinus to accommodate the anterior part of the foot. (Example is modern *Aporrhais pespelecani* (Linnaeus, 1758) from the Mediterranean Sea, LACM 149737x (= UCLA cat. no. 41586).

Subgenus *Helicaulax* Gabb, 1868

Type species: *Rostellaria ornata* d'Orbigny, 1843, by subsequent designation (COSSMANN, 1904), from the Turonian of France.

Diagnosis: Medium-sized, high-spired aporrhaids with whorls ornately sculptured by both axial and spiral elements and usually noded at the intersections; last whorl uniangulate; anterior rostrum elongate, narrow, straight; aperture subquadrate; posterior digitation reflexed, elongate, and adnate to spire at its base; outer lip extended, falcate, tapering posteriorly to a spike; inner lip thin to thick.

Discussion: *Helicaulax* resembles *Anchura* Conrad, 1860, in spire, sculpture, rostrum, and expansion of the outer lip, but it differs from *Anchura* in having, in addition to its expanded outer lip, an elongate, reflexed posterior digitation that is adnate to the spire (SOHL, 1960:103). In typical *Anchura* the anterior rostrum is deflected to the left in apertural view, but in *Helicaulax* it is straight. *Helicaulax* tends to develop flanges along the lateral segment of the outer lip. Although GABB (1868), when proposing the subgenus, placed two California species, in addition to the type species, in *Helicaulax*, neither of these California species can be retained in it (SOHL, 1960). *Helicaulax bicarinata* Gabb, 1864, of ?Albian age, is a *Tessarolax* Gabb, 1864, and *H. costata* Gabb, 1864, of Paleocene age is, according to STEWART (1927), an *Araeodactylus* Harris & Burrows, 1891. The chronologic range of *Helicaulax* is Cenomanian to Maastrichtian (SOHL, 1960). *Anchura* (*Helicaulax*) *condoniana* and *A.* (*H.*) ***tricosa*** are the only known Pacific Slope representatives of this subgenus, which is better known from the Western Interior and Gulf Coast of North America and from Europe. Whereas *Anchura* (*Anchura*) is more common in North American Upper Cretaceous deposits, *A.* (*Helicaulax*) is better represented in Europe.

Both *A.* (*H.*) *condoniana* and *A.* (*H.*) ***tricosa*** differ from the typical European forms in having the posterior digitation that sprouts adjacent to the whorl, thereafter unattached rather than adnate for part of its length. Additionally, the inner lip of these West Coast species is thick whereas that of *A.* (*H.*) *ornata* is very thin (COSSMANN, 1904:64). *Helicaulax* has been considered a subgenus of *Aporrhais* da Costa, 1778, by COSSMANN (1904) and WENZ (1940), but it differs from *Aporrhais* in having a laterally extended falcate outer lip that tapers to a spike rather than the broadly palmate digitated wing of *Aporrhais*. In *Aporrhais* the ornamentation tends to have a bicarinate orientation, but on *Helicaulax* and *Anchura* the complex sculpture has axial and spiral elements that commonly form nodes at intersections. On the last whorl, one or two of the spirals increase in strength to give the body whorl an unicarinate profile. Although *Helicaulax* differs from *Anchura* in having (1) a posterior digitation, (2) flanges along the lateral extension of the wing, (3) a straight anterior rostrum, *Helicaulax* is so similar to *Anchura* Conrad, 1860, that the two must be closely related. Of the two Pacific Slope species, *Anchura* (*Helicaulax*) *condoniana* has more poorly developed flanges along the wing and a shorter posterior prong that is late to develop and then callused over. It appears, thus, to be more similar to *Anchura* than is *A.* (*H.*) ***tricosa***. Except for its posterior digitation and straight anterior rostrum, *A.* (*H.*) *condoniana* is similar to *Anchura*. SOHL (1960:106) gives the range of *Anchura* as Cenomanian through Maastrichtian, and includes *Anchura turricula* Stephenson, 1952, from the Cenomanian age Woodbine of Texas despite its slight flanges on the lateral extension of the wing. The morphologies of both *A.* (*H.*) *condoniana* and *A. turricula* appear transitional between *A.* (*Helicaulax*) and *A.* (*Anchura*).

The two Pacific Slope Turonian species of *Anchura* (*Helicaulax*) have different known geographic and sediment distributions. *Anchura* (*H.*) *condoniana* has a more northern distribution in sandstone; *A.* (*H.*) ***tricosa*** has a more southern distribution in siltstone. Some of the morphological features of *A.* (*H.*) ***tricosa***, especially the long posterior prong and the expanded flanges on the lateral extension of the wing, seem appropriate to a quiet-water habitat on a fine-grained substrate, and the retrieval of these two species from different sediment types is probably related to their ecologic preferences. At present, the significance of the north–south distributions of these two species cannot be determined.

Anchura (*Helicaulax*) *condoniana* (Anderson, 1902)

(Figures 3–18)

Anchura condoniana ANDERSON, 1902:76, pl. 8, fig. 179; JONES, SLITER & POPENOE, 1978:xxii.9, pl. 1, fig. 15. Not *Anchura condoniana* Anderson of STADUM, 1973, cover photo = *A.* (*H.*) ***tricosa*** sp. nov.
Drepanochilus condoniana (Anderson): ANDERSON, 1958:166.

Diagnosis: A *Helicaulax* having a short posterior digitation roughly parallel to the shell axis, adjacent to the spire at its base, but not otherwise adnate; sculpture dominantly axial; fifth and sixth abapical spiral cords forming the angulation and continuing onto extended outer lip; outer lip falcate but only slightly flanged posteriorly and anteriorly along its lateral portion.

Description: Shell medium sized, high spired, turriculate, drawn out anteriorly into a moderately long, nearly straight anterior rostrum; whorls about eight in number, barely convex; suture appressed; protoconch unknown; growth line antispirally concave on the spire. Sculpture ornate, consisting of axial and spiral elements, the axial dominant on whorl sides; surface of spire ornamented by about 20 slightly arcuate axial ribs crossed by six spiral ribs forming nodes at axial-spiral intersections; the first four abapical ribs separated by interspaces of nearly equal width, the fifth, sixth, and seventh closer together, the fifth and sixth forming the peripheral angulation on the last whorl and continuing onto the extended outer lip. Aperture subquadrate, deeply broadly sinused between posterior spur and falcate digitation; outer lip with two extensions, a short straight, spurlike process adjacent to the spire and a long and falcate digitation, slightly flanged both posteriorly and anteriorly along its lateral portion, and grooved internally

→

Explanation of Figures 3 to 18

All figures ×1; all specimens, except LACMIP cat. no. 11537, coated with ammonium chloride.

Figures 3–10. *Anchura* (*Helicaulax*) *condoniana* Anderson, 1902. Figure 3: LACMIP cat. no. 10837 from UCLA loc. 4214, holotype, apertural view. Figure 4: CAS cat. no. 445.30 from CAS loc. 445, holotype, back view. Figures 5–8: LACMIP cat. no. 11540 from LACMIP loc. 10735, hypotype; Figure 5, right side; Figure 6, back; Figure 8, aperture. Figure 7: LACMIP cat. no. 11539 (latex pull) from LACMIP loc. 10735, hypotype, aperture. Figure 9: LACMIP cat. no. 11537 (latex pull) from LACMIP loc. 10726, hypotype, back, apparent bend in rostrum results from imperfection in rock mold. Figure 10: LACMIP cat. no. 11538 from UCLA loc. 4214, hypotype, back.

Figures 11–18. *Anchura* (*Helicaulax*) ***tricosa*** sp. nov. Figure 11: USNM cat. no. 465514 from USGS loc. 2759, holotype, aperture. Figure 12: USNM cat. no. 465515 from USGS loc. 2759, paratype, back. Figure 13: Paratype, USNM cat. no. 465518 from USGS loc. 2757, back. Figures 14, 15: USNM cat. no. 465517 from USGS loc. 2757, paratype; Figure 14, aperture; Figure 15, back. Figure 16: UCR cat. no. 7787/101 from UCR loc. 7787, paratype, aperture. Figure 17: LACMIP cat. no. 11541 from UCLA loc. 4235, paratype, back. Figure 18: Chapman College specimen figured by STADUM (1973) from Ladd Formation, upper Holz Shale Member, Santa Ana Mts., California, paratype, collected and prepared by Frank and Mabel Grouard. Photographs 3, 9, 10, 18 by Susuki; 4–8, 11–17 by De Leon.


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Table 1

Measurements (mm) of *Anchura* (*Helicaulax*) *condoniana* Anderson, 1902.

	H	D	Hp	Dp	Ha	Lw	Lp	A	Lr	Dp/Hp
CAS 445.30	45.0*	23.0	9.0	16.4	25.0	—	—	34°	—	1.8
UCLA 58437	58.7*	17.0†	6.4	14.6†	18.0*	30.0*	—	39°	24.0	2.3
LACMIP 11537●	42.8*	17.4†	7.8	14.8†	23.0*	—	—	35°	—	1.9
LACMIP 11538	41.5*	19.0†	7.0	15.0†	22.8*	—	—	36°	—	2.1
LACMIP 11539●	46.0*	—	—	—	29.0	31.0	11.0	30°	—	
LACMIP 11540	60.0	—	7.0	—	25.5	26.0			19.0	

* Specimen incomplete; † specimen crushed; ● latex pull. Abbreviations decrypted in Introduction.

opposite the external ridge; groove filled by thick callus deposit within aperture; inner lip very thick.

Holotype: CASG cat. no. 445.30.

Hypotypes: LACMIP cat. nos. 10837 (= UCLA 58437), 11538 from LACMIP loc. 24214 (= UCLA loc. 4214), Little Cow Creek; 11537 from LACMIP loc. 10726 (= CIT loc. 1032), Dry Creek; 11539–11540 from LACMIP loc. 10735 (= CIT loc. 1212), Little Cow Creek, Shasta Co., California.

Dimensions: See Table 1.

Type locality: CASG loc. 445, Forty-nine mine, near Phoenix, Jackson Co., Oregon (Anderson, 1902).

Distribution: Unnamed formation on Sidney Island (coll.: Peter Ward, 3 September 1992), British Columbia; Hornbrook Formation, Jackson Co., Oregon; Hornbrook Formation, Osburger Gulch Member, Siskiyou Co., California; Redding Formation, Bellavista Sandstone Member, rare, Frazier Silt Member, locally abundant, Melton Sandstone Member, rare, northeast of Redding, Shasta Co., California.

Geologic age: Middle to late Turonian, at LACMIP loc. 10876 (= CIT loc. 1042) associated with *Subprionocyclus neptuni* (Geinitz, 1849) (Matsumoto, 1960:102).

Remarks: The holotype was rescued from the ashes after the 1906 San Francisco earthquake. It now lacks the expanded wing and the rostrum of Anderson's (1902) figure (figure 179).

The extended wing of *Anchura* (*H.*) *condoniana* apparently formed before the posterior prong. Several specimens that have an extended falcate outer lip have no posterior spur (*e.g.*, the specimen figured by Jones *et al.*, 1978:pl. 1, fig. 15) and no indication that one has broken off. Apertures of specimens that have a spur have thicker callus deposits within the aperture, suggesting that these are more mature specimens.

Anchura (*Helicaulax*) *condoniana* differs from the similar *A.* (*H.*) ***tricosa*** in having the prong shorter and at less of an angle to the shell axis, only suggestions of flanges along the lateral extension of the outer lip, and a sturdier shell. The more strongly noded sculpture of *A.* (*H.*) *condoniana* is more similar to that of typical *Helicaulax* than is that of *A.* (*H.*) ***tricosa***.

Packard (1916:148) reported both *Alaria condoniana* and *Alaria falciformis* (Gabb, 1864) from the "*Actaeonella oviformis*" Zone of the Santa Ana Mountains. "*Actaeonella oviformis*" in the Santa Ana Mountains is *Trochactaeon* (*T.*) *packardi* (Anderson, 1958) and of Turonian age (Sohl & Kollmann, 1985). *Anchura* (*Helicaulax*) *condoniana* is also from the Turonian, but specimens so identified from the Santa Ana Mountains thus far examined are *Anchura* (*Helicaulax*) ***tricosa*** sp. nov. Popenoe (1942:fig. 4) recorded *Anchura* cf. *A. falciformis* (Gabb, 1864) from nine localities in the Santa Ana Mountains. The specimens from his localities in the Baker Canyon Sandstone and "Holz-Baker Transition" are also *A.* (*H.*) ***tricosa*** sp. nov. with the exception of those from LACMIP loc. 10100 (= CIT loc. 92) which are an undescribed new species of *Anchura* (*Anchura*). Popenoe's specimens of *A.* cf. *A. falciformis* from the upper Holz Shale belong to another undescribed species of *Anchura* (*Anchura*). The *Anchura* (*Helicaulax*) *condoniana* of Stadum (1973) from the Santa Ana Mountains Turonian is an unusually complete specimen of *Anchura* (*Helicaulax*) ***tricosa*** sp. nov. *Anchura* (*Helicaulax*) *condoniana* is locally abundant in the Redding region, but few specimens have the rostrum and extended outer lip preserved.

Anchura (*Helicaulax*) Saul & Popenoe,
tricosa sp. nov.

(Figures 11–18)

Anchura condoniana Anderson: Stadum, 1973, cover photo. Not *Anchura condoniana* Anderson, 1902.

Diagnosis: A large-sized *Helicaulax* with a long, posterior prong that is at an angle to the shell axis and a falcate outer lip broadened both anteriorly and posteriorly by angulate flanges.

Description: Shell large, high spired, drawn out anteriorly into a long, straight anterior rostrum; whorls about nine

Table 2

Measurements (mm) of *Anchura* (*Helicaulax*) ***tricosa*** sp. nov.

	H	D	Hp	Dp	Ha	Lw	Lp	A	Lr	Dp/Hp
LACMIP 11541	53.0*	19.7	7.7	14.3	25.0*	31.0	22.0	30°	13.8*	1.8
LACMIP 11542	43.7*	19.5	8.8	15.8	26.0*	32.5*	10.0*	25°	—	1.8
UCR 7787/101	52.1*	17.0†	7.5	14.7†	25.7	33.3*	19.0	28°	—	2.0
USNM 465514	42.0*	16.5	6.8	13.5	24.0*	33.0*	14.0	26°	—	2.0
USNM 465515	50.0*	18.0	6.7	12.0	31.0	45.5*	22.0	22°	8.0*	1.8
USNM 465517	37.0*	16.0	8.0	12.6	15.0*	29.6*	16.0	27°	—	1.6
USNM 465518	45.0*	21.0	9.0	15.8	19.0*	35.7*	14.5*	—	10.0*	1.8

* Specimen incomplete; † specimen crushed. Abbreviations decrypted in Introduction.

in number, wider than high, barely convex; suture impressed; body whorl angulate; anterior rostrum longer than the last whorl, slender, straight; early whorls with arcuate axial ribs; penultimate whorl ornamented by about 16 axial ribs crossed by straplike spiral ribs, about five on the spire and eight or nine on the body whorl; ribs forming nodes at intersections; first three abapical ribs separated by slightly wider interspaces, fourth and fifth closer together, forming the angulation of the body whorl that extends onto the outer lip digitation. Aperture subtriangular, deeply broadly sinused between posterior spur and falcate digitation; outer lip with two extensions, a relatively long, straight, spurlike posterior process basally adjacent to the spire and a long, and falcate digitation flanged both posteriorly and anteriorly along its lateral extension; posterior prong at an angle of 20°–30° to the shell axis.

Holotype: USNM cat. no. 465514.

Paratypes: LACMIP cat. nos. 11541 from UCLA loc. 4235, Holz Ranch, and 11542 from LACMIP loc. 15295, Silverado Canyon, Santa Ana Mts., Orange Co., California; UCR cat. nos. 7787/101, from UCR loc. 7787, Silverado Canyon, and 7788/20, from UCR loc. 7788, Silverado Canyon, Santa Ana Mts., Orange Co., California; USNM cat. nos. 465517–465518 from USGS loc. 2757, Silverado Canyon; USNM cat. nos. 465515–465516 from USGS loc. 2759, Ladd Canyon, Santa Ana Mts., Orange Co., California; Stadum specimen.

Type locality: USGS loc. 2759, lower Ladd Canyon, near Silverado Canyon, Santa Ana Mts., Orange Co., California.

Dimensions: See Table 2.

Distribution: Ladd Formation, upper Baker Canyon Sandstone and lower Holz Shale members, uncommon, Santa Ana Mts., Orange Co., California.

Geologic age: Turonian.

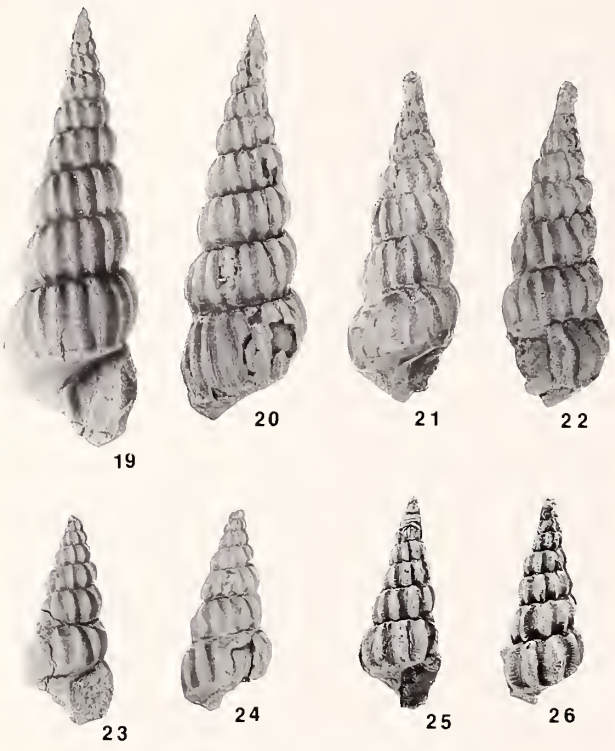
Remarks: *Anchura* (*Helicaulax*) ***tricosa*** differs from *A.* (*H.*) *condoniana* in having a broader falcate outer lip with angulately developed flanges, a longer posterior spur that extends at a greater angle to the shell axis, fewer axial ribs on the spire, a narrower pleural angle, and a slightly taller spire. On most available specimens, both axial and spiral sculpture appear more subdued than on *A.* (*H.*) *condoniana,* but this is at least partly due to preservation. A few specimens (*e.g.,* the holotype and paratypes UCR 7788/101–102) have the sculpture fairly well preserved. On these *A.* (*H.*) ***tricosa,*** the spirals are narrower and the interspirals wider, the axials fewer, and the nodes at the intersection stronger, especially on the angulation, than on *A.* (*H.*) *condoniana. Anchura* (*H.*) ***tricosa*** is from fine-grained muddy sandstone and siltstone, but *A.* (*H.*) *condoniana* is common in beds of coarser grain. A fragmentary specimen (USNM cat. no. 465516) of *A.* (*H.*) ***tricosa*** has a body whorl diameter of about 20 mm, suggesting a height of at least 72 mm, a size close to twice that of any *A.* (*H.*) *condoniana.* As discussed under *A.* (*H.*) *condoniana,* Packard's (1916) *Alaria condoniana* from the Santa Ana Mountains is *Anchura* (*H.*) ***tricosa*** as is Popenoe's (1942) *Anchura* cf. *A. falciformis* from the upper Baker Canyon Sandstone and lower Holz Shale members of the Ladd Formation. Popenoe's (1942) specimens of *A.* cf. *A. falciformis* from the upper Holz Shale differ from *A.* (*H.*) ***tricosa*** in lacking the posterior prong, in having a shorter lateral extension to the wing that lacks flanges, and in being more coarsely sculptured. USNM 465515 was encrusted with calcareous tubes (probably annelid) on both apertural and abapertural sides of the wing and on the base of the body whorl adjacent to the lip. These encrustations were probably subsequent to the death of the gastropod.

Etymology: The species name is from the Latin *tricosus,* meaning full of tricks or wiles.

Superfamily ?Janthinacea, Lamarck, 1812

Family Epitoniidae Berry, 1910

Sohl (1964) placed the Epitoniidae in the order Cephalaspidea, but Ponder & Warén (1988) have included it in



Explanation of Figures 19 to 26

All figures ×1; all specimens coated with ammonium chloride.

Figures 19–24. *Confusiscala*? ***sulfurea*** sp. nov. Figures 19, 20: CAS cat. no. 66549.01 from CAS loc. 66549, holotype; Figure 19, aperture; Figure 20, back. Figures 21, 22: LACMIP cat. no. 11544 from UCLA loc. 7233, paratype; Figure 21, apertural side; Figure 22, back. Figures 23, 24: LACMIP cat. no. 11545 from UCLA loc. 4252, paratype; Figure 23, aperture; Figure 24, back.

Figures 25, 26. *Confusiscala*? ***juvenca*** sp. nov. Figures 25, 26: LACMIP cat. no. 11543 from LACMIP loc. 10735, holotype; Figure 25, apertural side; Figure 26, back. Photographs, 19–24 by De Leon; 25, 26 by Susuki.

the superfamily Janthinoidea, Lamarck, 1812, which they place near the end of the Mesogastropoda.

Genus *Confusiscala* de Boury, 1909

Type species: by original designation and monotypy, *Scalaria dupiniana* d'Orbigny, 1842, from Aube, France, of Albian age.

Confusiscala was originally considered to be a subgenus of *Amaea* by DE BOURY (1909). It has continued to be treated as a subgenus by several workers, including STEWART (1927), who placed it as a subgenus of *Epitonium* Röding, 1798, WENZ (1940) as a subgenus of *Amaea* H. & A. Adams, 1853, and DURHAM (1937) as a subgenus of *Opalia* H. & A. Adams, 1853. GARDNER (1876) had included *Scalaria dupiniana* and its allies in *Opalia,* and the two species described here resemble *Opalia*. *Confusiscala*? ***juvenca*** is as similar to *Opalia* as to *Confusiscala*.

COSSMANN (1912:73) considered *Confusiscala* a full genus and characterized it as having axial ribs and varices that do not cross the basal cord, which is visible on the spire supradjacent to the suture. The axial ribs are not always aligned with ribs of adjacent whorls, and they are posteriorly somewhat reflected toward the basal cord. Whorl sides are completely overrun by fine spiral threads. The base is rather flat and circumscribed peripherally by the somewhat projecting basal cord against which the axial ribs abut. The basal disk is ornamented by fine spiral threads and crossed by radiating slightly sinuous growth lines. The aperture has a small posterior canal against the basal cord of the penultimate whorl.

COSSMANN (1912) listed occurrences of species referred to *Confusiscala* from nearly all continents, but the genus has apparently not been recognized in the Western Interior, Atlantic, and Gulf Coast Cretaceous faunas of the United States. The genus ranges from Neocomian (GARDNER, 1876) through Maastrichtian.

Confusiscala? ***sulfurea*** Saul & Popenoe, sp. nov.

(Figures 19–24)

Opalia (*Confusiscala*) *mathewsonii* (Gabb)?: DURHAM, 1937: 504, pl. 56, fig. 23.

Diagnosis: A medium-sized *Confusiscala* with axial ribs that extend from suture to basal cord and increase gradually in number, 12 on the fifth whorl and 19 on the 12th whorl; basal cord variably exposed on spire.

Description: Shell medium sized, turreted; pleural angle about 24°; whorls 12, moderately convex, width more than twice height; sutures impressed, not always anterior to the basal cord; basal disk flattened, bordered peripherally by a strong cord and centrally by a low swelling about an indistinct umbilical depression. Whorl sides sculptured by strong, scarcely sigmoid, swollen, round crested axial ribs, overridden by fine spiral threads; ribs just reaching the posterior suture and terminating at the basal cord, nearly aligned with ribs of adjacent whorls, but not confluent, 12 ribs on fifth whorl, 19 ribs on twelfth whorl; rib interspaces round bottomed, about equal in width to the ribs; spiral sculpture of low, spaced, spiral threads of alternating strength; base with fine more closely spaced nearly equal spiral threads; growth line a little prosocline at the suture, broadly barely concave medially. Aperture subquadrate; inner lip narrow, a little thickened.

Holotype: CASG cat. no. 66549.01 (= CASG cat. no. 7010, DURHAM, 1937:pl. 56, fig. 23)

Paratypes: LACMIP cat. no. 11545 from UCLA loc. 4252, Ashland, Oregon; and 11544 from UCLA loc. 7233, Sulphur Creek, Redding quadrangle, Shasta Co., California.

Dimensions: See Table 3.

Type locality: CASG loc. 66549, Hagerdorn Ranch, 4 miles (6.4 km) northwest of Montague, Siskiyou Co., California.

Distribution: Hornbrook Formation, ?Osburger Gulch Member, near Ashland, Jackson Co., Oregon; Hornbrook Formation, ?Osburger Gulch Member, near Montague, Siskiyou Co.; Redding Formation, Bellavista Sandstone Member, Redding area, Shasta Co., California.

Geologic age: Turonian.

Remarks: Three species resembling *Confusiscala* have been described from the Pacific Slope Cretaceous faunas. The first of these, "*Scalaria*" *mathewsonii* Gabb, 1864, was referred to *Confusiscala* by STEWART (1927). It is based on a single, poorly preserved specimen consisting of four incomplete, partially exposed whorls, from "near Martinez," Contra Costa Co., California. Deposits "near Martinez" range in age from Albian to Maastrichtian. Preservation of the holotype of "*S.*" *mathewsonii* suggests that it is of Maastrichtian age. In *C.*? ***sulfurea*** the basal cord is less strong, the whorls are less convex, and the axial ribs are narrower with comparatively wider interspaces. If STEWART's (1927) estimate that *C.*? *mathewsonii* had about 12 axial ribs is correct, *C.*? ***sulfurea*** has the greater number of ribs.

The second species is *Mesostoma* (?) *newcombii* Whiteaves, 1903, from the Cedar District Formation of Sucia Island, San Juan Co., Washington. It is Campanian in age and differs from *Confusiscala*? ***sulfurea*** in its much larger size and relatively shorter whorl height. In *C. newcombii* axial ribs fade toward the posterior suture, creating a whorl profile that is broadest near its base, whereas *C.*? ***sulfurea*** has longer ribs and a more evenly rounded whorl profile.

The third and even larger species is *Cerithium suciense* Packard, 1922, described from a specimen consisting of two whorls (height 59 mm, diameter 44 mm) probably from the Cedar District Formation on Sucia Island, San Juan Co., Washington (UCB loc. 2209), which is of mid Campanian age. Another and larger specimen consisting of eight whorls (height incomplete 162 mm, diameter 56 mm) is available from that part of the Chatsworth Formation in the Simi Hills yielding *Metaplacenticeras* aff. *M. pacificum* (Smith, 1900). *Confusiscala suciense* is from the *Hoplitoplacenticeras vancouverense* to *Metaplacenticeras pacificum* zones and of mid to late Campanian age. *Confusiscala*? ***sulfurea*** is much smaller than *C. suciense* and lacks the strong posterior growth line sinus just subjacent to the suture.

The holotype of *Confusiscala*? ***sulfurea*** was described as being "from the upper Chico beds," reflecting common usage 60 years ago, but the Cretaceous strata near Montague are now referred to as the Hornbrook Formation. Present in the matrix of the holotype are specimens of *Turritella hearni* Merriam, 1941, a species of Turonian age that is present in the lower Hornbrook Formation.

Table 3

Measurements (mm) of *Confusiscala*? ***sulfurea*** sp. nov. and *C.*? ***juvenca*** sp. nov.

	H	D	Hp	Dp	A	R	Dp/Hp
C.? ***sulfurea***							
CASG 66549.01	51.3	19.0	8.5	14.4	22°	19	1.7
LACMIP 11544	45.8	14.6†	7.5	9.4†	21°	13	1.2
LACMIP 11545	27.2	12.5	5.6	10.5†	26°	13	1.9
C.? ***juvenca***							
LACMIP 11543	27.4	10.9	5.0	8.9	31°	10	1.8

* Specimen incomplete; † specimen crushed. Abbreviations decrypted in Introduction.

Confusiscala? ***sulfurea*** is not a typical *Confusiscala*. Its axial ribs, like those of *C.*? *mathewsonii*, extend from the posterior suture to the basal cord, and it differs from *C. dupiniana* in having longer axial ribs and a more evenly rounded whorl profile.

Etymology: The species name ***sulfurea*** is Latin and refers to the occurrence of this species on Sulphur Creek, Shasta Co., California.

Confusiscala? ***juvenca*** Saul & Popenoe, sp. nov.

(Figures 25, 26)

Diagnosis: An *Opalia*-like epitoniid with 10 to 12 strong, shouldered axial ribs per whorl and a strong basal disk; whorls overlain with fine cancellate sculpture produced by fine spiral threads and growth lines.

Description: Shell of medium size, turreted; pleural angle about 30°; whorls eight or nine in number, moderately convex, width about twice height; sutures deeply impressed; basal disk flattened, a little concave, bordered peripherally by a thick and rounded cord; no umbilicus. Whorl sides sculptured; axial sculpture of 10 to 12 nearly straight, slightly oblique, swollen, round-crested ribs, shouldered at the posterior suture, abruptly terminating at the basal cord, and nearly or quite in alignment with the ribs of adjacent whorls, but not confluent; rib interspaces round bottomed, equal in width to the ribs; spiral sculpture of low, faint, rather widely spaced spiral threads alternating with finer spiral threads and crossed by growth lines producing an overall finely cancellate appearance, extending over the basal disk; growth line with a shallow (about equal to ½ the axial rib thickness) but well-marked sinus at the shoulder. Aperture probably almost quadrate with a spoutlike extension at its inner anterior border and a posterior notch at the shoulder; inner lip thin, narrow, reflected onto base; outer lip unknown.

Holotype: LACMIP cat. no. 11543.

Dimensions: See Table 3.

Type locality: LACMIP loc. 10735 (= CIT loc. 1212), Little Cow Creek, 2 miles (3.2 km) NE of Frazier Corners, Shasta Co., California.

Distribution: Redding Formation, Frazier Siltstone Member, Redding area, Shasta Co., California.

Geologic age: Turonian.

Remarks: *Confusiscala*? ***juvenca*** differs from *C.*? ***sulfurea*** in having strongly shouldered and straighter axial ribs, fewer, more irregular spirals on its basal disk, a posterior growth line sinus, and the suture posterior to the basal cord so that the basal cord does not show on the spire. In *C.*? ***juvenca*** the growth line has a posterior notch like that of *C. suciensis,* but the ribs are much straighter and longer, extending from the shoulder to the basal cord without diminished strength.

Confusiscala? ***juvenca*** has many of the characteristics of the genus *Opalia* (type species *Opalia australis* (Lamarck, 1822)), but differs in at least two respects: *C.*? ***juvenca*** has a well-marked but shallow posterior sinus to the growth line at the shoulder, and *C.*? ***juvenca*** apparently lacks the spiral bands of punctations of *Opalia.* Although the holotype of *C.*? ***juvenca*** appears well preserved, recrystalization and mineralization of the specimen may have obscured some details, and such details as punctations could be obscured. This species is geologically older and more strongly shouldered than the Maastrichtian, Gulf Coast species assigned to *Opalia* by SOHL (1964).

Etymology: The species name ***juvenca*** is Latin, meaning young, and refers to the occurrence of this species in the Little Cow Creek drainage.

Order NEOGASTROPODA Thiele, 1929

Superfamily MURICACEA Rafinesque, 1815

Family SARGANIDAE Stephenson, 1923

STEPHENSON (1923) proposed the new family Sarganidae to contain *Sargana* Stephenson, 1923, distinguishing it from Muricidae on the basis of the columellar folds and the flattened spire. SOHL (1964:173) and WENZ (1941:1082) have placed *Sargana* in the subfamily Rapaninae of the family Muricidae, but PONDER & WARÉN (1988) included Rapaninae in the Thaidinae and recognize Sarganinae. The placement of *Sargana* and of Sarganinae in Muricidae is questioned by GARVIE (1991), who quotes uncompleted work on protoconchs by Klaus Bandel as indicating that *Sargana* is a close relative of *Trichotropis,* and this placement was abrogated by GARVIE (1992), who places *Sargana* without attribution or mention of morphological criteria in the Cancellariidae. The spiny shell of *Sargana* does not resemble that of *Trichotropis.* In several features—pyriform shape, flattened protoconch, complex spiny sculpture—*Sargana* resembles *Pyropsis* Conrad, 1860, which STEPHENSON (1941) placed in the Pyropsidae. SOHL (1964) considered the separation of the Pyropsidae as a family too drastic and left it in the Vasidae H. & A. Adams, 1853, but SAUL (1988) included *Pyropsis* in Tudiclidae Cossmann, 1901, placing it in the superfamily Muricacea. In shape and placement of the posterior siphonal notch, the aperture of *Sargana* resembles that of tudiclids more than it does that of muricines. The aperture does not resemble that of trichotropids, and unlike the many muricines that have a posterior outer lip sinus at the shoulder rather than against the body whorl, the Sarganidae have a well-developed posterior sinus against the body whorl. The aperture of *Sargana* also differs from that of cancellariids in forming a narrow, constricted anterior canal that is abruptly confined posteriorly, whereas in cancellariids the anterior canal is typically broad and not confined at its apertural junction.

Praesargana Saul & Popenoe, gen. nov.

Type species: *Trophon condoni* White, 1889.

Diagnosis: Small, very low-spired sarganids with moderate, lacinate anterior siphon, and a shallow umbilical depression bounded by a roughened fasciole. Outer lip bearing a tubercle opposite the spiral fold of the inner lip. Siphonal canal short and bent to the left.

Discussion: ***Praesargana*** lacks the deep spiral sulcus at the base of the body whorl of *Sargana.* It has finer, more regular, and nodular rather than spinose sculpture; a smaller and shallower umbilical depression; and a shorter, straighter and more open siphonal canal than *Sargana.*

The resemblance of ***Praesargana*** to *Sargana* suggests inclusion of ***Praesargana*** in the Sarganinae. The protoconch of ***Praesargana*** is paucispiral, consisting of but two rapidly expanding flattened, carinate whorls. Because the shells are recrystallized and entombed in tenacious, well-cemented matrix, any fine sculpture is as yet unknown. In shell form and sculpture ***Praesargana*** does not resemble *Trichotropis.* Although its anterior siphonal canal is broader than that of *Sargana,* the anterior canal of ***Praesargana*** is abruptly confined posteriorly and much narrower than that of cancellariids.

The generic name is compounded of *Sargana,* derived from the Greek *sargane,* meaning braid, plait, basket, and the Latin prefix *Prae,* meaning before, and is of feminine gender.

Praesargana *condoni* (White, 1889)

(Figures 27–37)

Trophon condoni WHITE, 1889:21, pl. 3, figs. 4–5; ANDERSON, 1958:168; JONES, SLITER & POPENOE, 1978:xxii.9, pl. 1, figs. 8–9.

Diagnosis: As for the genus.

Description: Shell small; spire very low; whorls rapidly expanding, roundly shouldered and convex posteriorly, be-

coming concave on the short broad siphonal neck; anterior end of siphon rounded and lacinate; suture appressed; ramp slightly concave; umbilical depression shallow, narrow, bounded by a roughened fasciole. Protoconch paucispiral, consisting of about two rapidly expanding, carinate whorls surrounding an apical dimple. Sculpture of about 12 strong, evenly spaced, rough, round-topped spiral cords crossed by about 20 nearly straight, collabral ribs, producing a coarse cancellate appearance, strong at the whorl shoulder, diminishing anteriorly, scarcely evident on the basal fourth of the last whorl. Aperture broadly subovate, its two lips, meeting by the thickening of each as the shell approaches maturity, extend back upon the ultimate volution; apertural callus at posterior juncture of inner and outer lips bearing a shallow siphonal groove extending spireward to the shoulder of the penultimate whorl; aperture sharply constricted at its passage into anterior canal by a projecting tubercle on the inner margin of the outer lip, opposing a similarly placed spiral fold on the inner lip; siphonal canal short, narrow, slotlike and strongly bent to the left, margins parallel.

Syntypes: USNM cat. no. 20122 (2 specimens).

Hypotypes: LACMIP cat. no. 10807 (= UCLA cat. no. 58443) from LACMIP loc. 10735 (= CIT loc. 1212), Little Cow Creek, 2 miles (3.2 km) northeast of Frazier Corners, Shasta Co.; LACMIP cat. no. 11546 from UCLA loc. 5422, Rancheria Gulch, Siskiyou Co.; LACMIP cat. no. 11585 from LACMIP loc. 10735 (= CIT loc. 1212), Little Cow Creek, Shasta Co.; LACMIP cat. no. 11586 from UCLA loc. 4214, Little Cow Creek, Shasta Co., California.

Dimensions: See Table 4.

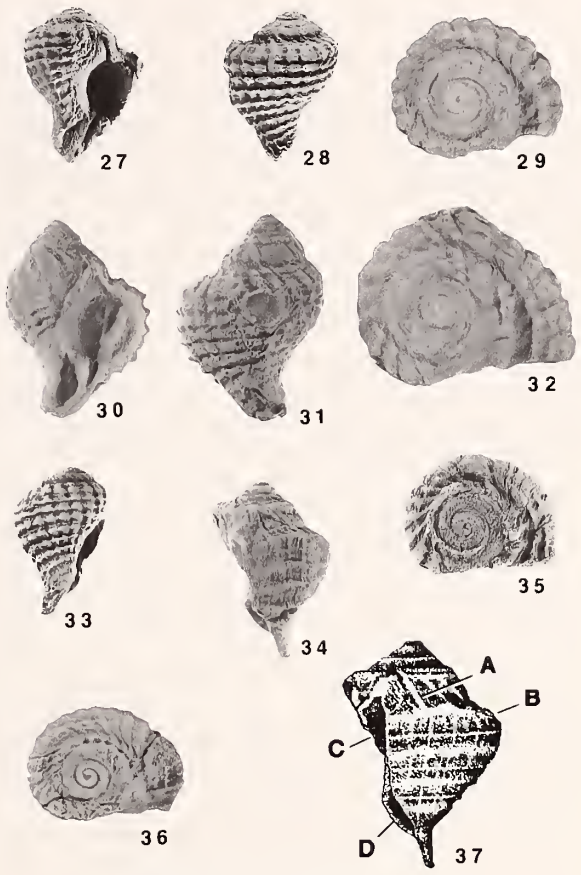
Type locality: "Chico Group, Little Cow Creek Valley, about eighteen miles [29 km] east of Redding, Shasta County" (WHITE, 1889).

Distribution: Hornbrook Formation, Osburger Gulch Sandstone Member, Rancheria Gulch, Siskiyou Co.; common in sandstone lenses near middle of Frazier Silt Member of Redding Formation, Redding area, Shasta Co., California; reported from "Turonian of Putah Creek, near the Napa-Yolo County line" (ANDERSON, 1958:168).

Geologic age: Turonian.

Remarks: ***Praesargana*** *condoni* resembles *Sargana stantoni* (Weller, 1907), type species of *Sargana* from Maastrichtian of Gulf and Atlantic coasts, and *S. geversi* (Rennie, 1930) from Senonian of Pondoland, but *P. condoni* lacks their basal constriction. Its sculpture is less spiny than that of *S. stantoni,* and its protoconch is not as strongly carinate. It has more spiral cords on the ramp than *S. geversi* and fewer than *S. stantoni.* It also resembles "*Rapana*" *tuberculosa* Stoliczka (1868) from the Trichinopoly beds of South India, but differs from this species in its more abruptly constricted last whorl at the beginning of the siphonal canal. ***Praesargana*** *condoni* is geologicaly older than these three species of *Sargana.*

Praesargana *condoni* is morphologically variable. The strength of the spiral cords varies from even to irregular with four commonly stronger, the shoulder cord and three alternate anterior cords (Figures 34, 37). The shoulder is



Explanation of Figures 27 to 37

All specimens coated with ammonium chloride; unless otherwise indicated figures are ×1.

Figures 27–37. *Praesargana condoni* (White, 1889). Figures 27–29, 33: LACMIP cat. no. 10807 from LACMIP loc. 10735, hypotype; Figure 27, aperture; Figure 28, back; Figure 29, apical view, ×1.5; Figure 33, left side. Figures 30–32: LACMIP cat. no. 11546 from UCLA loc. 5422, hypotype, specimen with rounded shoulder and higher spire; Figure 30, aperture; Figure 31, back; Figure 32, apical view, ×1.5. Figures 34, 36, 37: LACMIP cat. no. 11586 from UCLA loc. 4214, hypotype; Figure 34, right side, showing bulging portion of last whorl; Figure 36, apical view, higher spired specimen than 11585 (Figure 35) and 10807 (Figures 27–29, 33). Figure 37, computer scan of Figure 34 enhanced through use of Canvas 3.0 to show position of present aperture edge, varix, and former position of posterior canal, ×1.33; A, varix with posterior sinus; B, shoulder; C, aperture, D, umbilical fasciole. Figure 35, LACMIP cat. no. 11585 from LACMIP loc. 10735, hypotype, apical view, showing suppression of axial ribbing and some bulging of whorl on last third of body whorl, ×1.5. Photographs 27, 28 by Susuki; 29–36 by De Leon.

Table 4

Measurements (mm) of ***Praesargana*** *condoni* (White, 1889).

	H	D	Hp	Dp	Ha	Hs	A	Dp/Hp	Hp/Hs
UCLA 59443	19.0	15.0	2.0	7.6	3.0	?	114°	3.8	?
LACMIP 11546	27.3	21.2	4.8	8.9	6.5	1.0	88°	4.9	4.8
LACMIP 11585	17.6	16.9	1.8	6.8	3.4	‡	110°	3.8	?
LACMIP 11586	23.7	21.6	3.0	10.5	5.0	1.7	115°	3.5	1.8

* Specimen incomplete; ‡ shoulder overlapped. Abbreviations decrypted in Introduction.

very angulate on some specimens but rounded on others. The spire height varies from nearly flat (Figures 27–29, 33) to conical (Figures 30–32). Additionally, on some specimens an abrupt enlargement of the whorl makes a bulge near the aperture (Figures 34, 36, 37).

ANDERSON (1958:168) claimed that the species occurs in considerable numbers near the Yolo-Napa County line at Putah Creek, but a search of the University of California, Berkeley, Museum of Paleontology and the California Academy of Sciences collections for specimens from that vicinity turned up only two specimens of the species from one locality, CASG loc. 2360, "Devils Gate," on Berryessa Creek, 12,000 ft (3700 m) below the top of the Chico group, on Hamilton Ranch "near the top of the big conglomerate." Anderson said that his specimens were collected from conglomerates, suggesting that ***Praesargana*** *condoni* occurs in the Venado Formation.

Explanation of Figures 38 to 43

All figures ×1; all specimens coated with ammonium chloride.

Figures 38–43. ***Cydas*** *crossi* (Anderson, 1958). Figures 38–40: CAS cat. no. 61934.01 from CAS loc. 61934, holotype; Figure 38, aperture; Figure 39, back; Figure 40, right side. Figures 41–43: LACMIP cat. no. 11547 from LACMIP loc. 10735, hypotype; Figure 41, apical view; Figure 42, apertural view showing pseudofold on columella; Figure 43, back. Photographs 38–41 by De Leon; 42, 43 by Susuki.

Superfamily BUCCINACEA Rafinesque, 1815

Family PERISSITYIDAE Popenoe & Saul, 1987

Genus ***Cydas*** Saul & Popenoe, gen. nov.

Type species: *Volutoderma crossi* Anderson, 1958, from the West Coast Turonian.

Diagnosis: Medium-sized, fusiform perissityids with a sloping shoulder, broadly rounded periphery, and short anterior siphonal neck that has near its anterior end a well-developed siphonal fasciole. Whorls ornamented by rounded axial ribs on posterior half of whorls over-ridden by flat-topped spiral cords. Outer lip expanded to form a rim and having a posterior, four medial, and an anterior denticle within, the central two medial denticles stronger; lip notched posteriorly at the shoulder between posterior and adapical medial denticles. Aperture elongate, narrow, sharply angled and constricted posteriorly. Parietal lip narrow and thin with one or two posterior denticles coinciding with spiral cords, two pseudofolds on columella just anterior to base of whorl; inner lip broader and thicker on columella, wrapped over to form a pseudoumbilicus anterior to fasciole.

Discussion: ***Cydas*** displays a typical perissityid pattern of apertural denticles. It is most similar to *Pseudocymia* Popenoe & Saul, 1987, but in ***Cydas*** the outer lip denticles are separated into three groups and the middle two of the medial group are the strongest, the shoulder is obscure, and the spiral cords are straplike. The posterior notch at the shoulder of the outer lip is suggestive of *Columbellaria* Rolle, 1861, but the notch is less well developed in ***Cydas*** and the inner lip is not expanded onto the last whorl.

The genus is named for Cydas of Gortyna, son of Antitalces, and is of masculine gender.

Cydas *crossi* (Anderson, 1958)

(Figures 38–43)

Volutoderma crossi ANDERSON, 1958:174, pl. 16, figs. 3, 3a.

Diagnosis: As for the genus.

Description: Shell of medium size, rounded fusiform; spire and last whorl of approximately equal height; apical angle about 35°; spire with five, moderately convex whorls slightly concave just below suture; body whorl ornamented with about 12 straplike spiral cords separated by interspaces as

Table 5

Measurements (mm) of ***Cydas*** *crossi* (Anderson, 1958).

	H	D	Hp	Dp	Ha	A	La	Dp/Hp
CAS 61934.01	34.2*	13.9	7.0	10.8	13.6*	33°	21	1.5
LACMIP 11547	33.0*	15.5	7.4	11.5	15.5	38°	—	1.5

* Specimen incomplete. Abbreviations decrypted in Introduction.

wide as spirals, posterior spiral separated from posterior suture and succeeding abapical spiral by interspace twice its width; axial sculpture of about 12 low, rounded ribs and a varix per whorl; ribs gently arched and slightly concave to the aperture; varices, not well preserved in available specimens but developed at radial intervals of about 300°; aperture elongate, sharply angled posteriorly, contracted anteriorly; inner lip narrow, thin parietally, thicker and wider on columella, bearing one or two denticles near posterior end, and two short, slightly oblique columellar pseudofolds just anterior to whorl base; anterior tip of columella flexed slightly to the left, bearing a fasciole near its tip; outer lip expanded into a rim, bearing within a posterior, four medial, and an anterior denticle; two central medial denticles stronger; lip notched posteriorly at shoulder; labral profile nearly paralleling shell axis, but with a broad and shallow sinus concave toward the aperture.

Holotype: CASG cat. no. 61934.01 (= CASG 10675).

Hypotype: LACMIP cat. no. 11547 from LACMIP loc. 10735 (= CIT 1212), Little Cow Creek, 2 miles (3.2 km) northeast of Frazier Corners, Shasta Co., California.

Dimensions: See Table 5.

Type locality: CASG loc. 61934 (= CASG 1293D), "SW ¼ sec. 4, T32N, R3W, Frazier Corners, Shasta Co." (Anderson, 1958).

Distribution: Known only from the Frazier Siltstone Member of the Redding Formation in the vicinity of the type locality.

Geologic age: Late Turonian, associated with *Subprionocyclus* sp.

Remarks: Only two specimens of this species are available. Neither is complete; both lack an adequately preserved protoconch. The holotype is weathered; its shell surface is eroded, and the shell was riddled by endobionts, but the shell surface of the less complete hypotype is well preserved. The aperture of the holotype is complete enough to display a perissityid denticle pattern. The posterior "siphonal" notch is shallow, but its placement on the shoulder resembles the placement of the siphon in the Columbellinidae. Some of the early volutes, as for example the species herein assigned to *Carota,* also have an outer lip notch at the shoulder.

Cydas *crossi* resembles *Pseudocymia aurora* Popenoe & Saul, 1987, but ***C.*** *crossi* is more slender, has a less angulate shoulder, fewer denticles within the outer lip, and the denticles are more clearly divided into posterior, medial, and anterior groups. ***Cydas*** *crossi* resembles *Murphitys michaeli* Saul, 1987, in overall shape but is higher spired, more slender, has spiral cords that are more straplike and regular, and has two short pseudofolds on its columella rather than the two folds of *Murphitys.*

In shape and sculptural components, ***Cydas*** *crossi* resembles the type species of *Trachytriton* Meek, 1864, *Trachytriton vinculum* (Hall & Meek, 1856), from the late Campanian–early Maastrichtian of Colorado, Montana, South Dakota, and Wyoming. ***Cydas*** *crossi* differs from *T. vinculum* in having a perissityid-like distribution of denticles within the aperture, stronger spiral sculpture consisting of fewer more nearly equal, straplike spiral cords, about half the number of axial ribs, and more irregularly developed varices, both as to strength and frequency.

Family Buccinidae Rafinesque, 1815

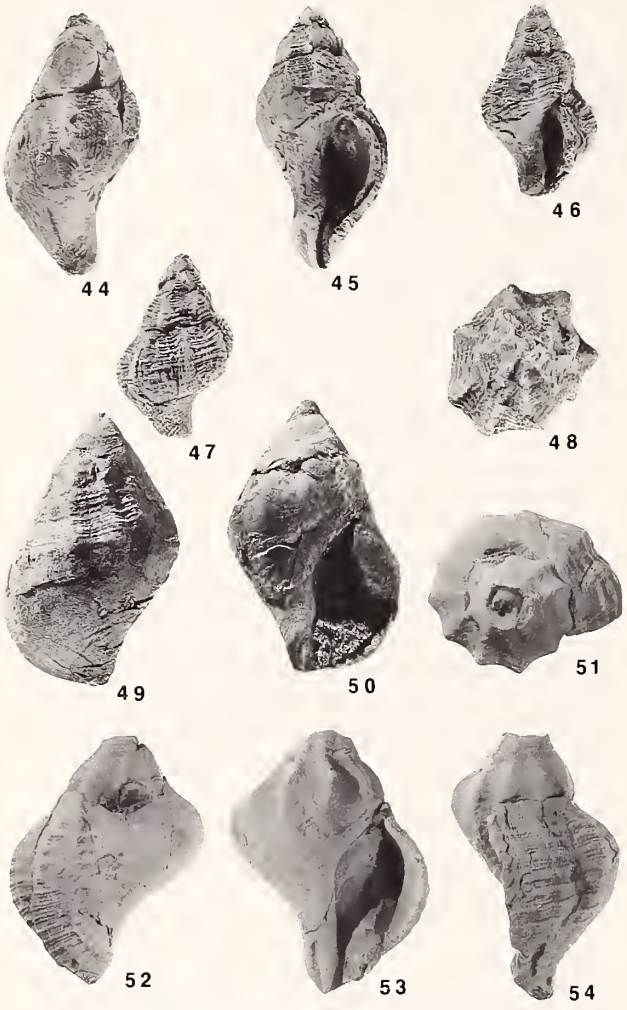
Genus *Eripachya* Gabb, 1869

Type species: *Neptunea ponderosa* Gabb, 1864, subsequent designation Cossmann, 1901, from the Campanian of California.

Diagnosis: Medium-sized, broadly fusiform buccinids having plumply convex whorls; suture sinuous, impressed. Spiral ornamentation of alternate width ribs; collabral sculpture of strong, nearly straight ribs strongest at periphery and dying out before the suture and the siphonal neck. Aperture eye-shaped, rounded posteriorly, attenuated and gently twisted anteriorly; siphonal canal narrow, moderately long; columella strongly twisted; siphonal neck bearing a narrow false umbilicus bounded by a low but well-marked fasciole; inner lip smooth, overlain by thin callus, concave in its parietal portion, gently sinuous in its columellar position; outer lip thin, lirate within.

Range: Turonian to Campanian.

Discussion: *Eripachya* has long been misunderstood. Cossmann (1901) indicated that it was poorly characterized because the specimens were not well preserved, and he doubted that the other two species included by Gabb (1869) in *Eripachya, Neptunea perforata* Gabb, 1864, and *Neptunea hoffmanni* Gabb, 1864, were congeneric. Stewart (1927) placed these latter species in the cancellariid genus *Paladmete* Gardner, 1916, but Anderson (1958) referred them back to *Eripachya* which they do not resemble. The specimen of the type species, *E. ponderosa,* figured



Explanation of Figures 44 to 54

Unless otherwise indicated, figures are ×1; all specimens coated with ammonium chloride.

Figures 44–48. *Eripachya* ***vaccina*** sp. nov. Figures 44, 45: LACMIP cat. no. 11548, from LACMIP loc. 10760, holotype; Figure 44, back; Figure 45, aperture.

Figures 46–48: LACMIP cat. no. 11549, from LACMIP loc. 10776, paratype; Figure 46, aperture; Figure 47, back; Figure 48, apical view, ×1.5.

Figures 49–54. *Eripachya ponderosa* (Gabb, 1964). Figures 49, 50, ANSP cat. no. 4186 from Tuscan Springs, Tehama Co., Calif., lectotype; Figure 49, back; Figure 50, aperture. Figures 51–54: CAS cat. no. 53344.01 from CAS loc. 53344, hypotype; Figure 51, apical view; Figure 52, back view; Figure 53, aperture; Figure 54, right side. Photographs 44–47, 49, 50 by Susuki; 48, 51–54 by De Leon.

by STEWART (1927:pl. 20, fig. 9) is somewhat crushed into a less bucciniform shape. *Eripachya* resembles the late Cenozoic *Lirabuccinum* Vermeij, 1991, but *Lirabuccinum* has a shorter and straighter columella, more numerous collabral ribs, and its spiral ribbing is relatively even. The spiral sculpture of *Eripachya* has a graded or bundled aspect with wider riblets grouped together, grading into finer interspace riblets somewhat like that of *Kelletia kelletii* (Forbes, 1852).

Eripachya ***vaccina*** Saul & Popenoe, sp. nov.

(Figures 44–48)

Diagnosis: A slender *Eripachya* with about eight collabral ribs per whorl.

Description: Shell of medium size, robust, broadly fusiform, pleural angle of about 49°; spire approximately three-fifths the total height of the shell, with about six plumply convex whorls about twice as wide as high; siphonal neck slightly longer than the spire with a well-marked fasciole; suture undulating, slightly appressed. Protoconch unknown. Sculpture of fine spiral cords and strong collabral ribs; spiral ornamentation of five or six low, flat, narrow primary cords on penultimate whorl, and about 15 on body whorl and neck, separated by interspaces wider than the primaries, and alternating with narrow threadlike secondary spirals; seven or eight sharp-crested collabral ribs per whorl separated by flatish interspaces, twice the width of the ribs; ribs on body whorl diminishing anterior to the periphery, not present on base or siphonal neck, disappearing at about the mid-length of whorl. Aperture eye-shaped, angulate at the suture, broad posteriorly, attenuated anteriorly; siphonal canal narrow, of moderate length, twisted abaperturally and to the left anteriorly, bearing above its tip a narrow and shallow umbilical chink bounded by a low but well-marked fasciole; inner lip smooth, without folds, parietal lip short, columellar portion nearly straight, bent at the fasciole and with a free edge forming a pseudoumbilicus with the fasciole; outer lip unknown.

Holotype: LACMIP cat. no. 11548.

Paratype: LACMIP cat. no. 11549 from LACMIP loc. 10776 (= CIT loc. 1197), Stinking Creek, Shasta Co., California.

Type locality: LACMIP loc. 10760 (= CIT loc. 1438), north side Little Cow Creek, Shasta Co., California.

Dimensions: See Table 6.

Geologic age: ?Early Turonian, horizon of *Tragodesmoceras*.

Distribution: Redding Formation, Bellavista Sandstone Member of the Redding area, Shasta Co., California.

Remarks: *Eripachya* ***vaccina*** is a rare form; only two incomplete specimens are in the LACMIP collection. Both specimens lack a protoconch, the outer lip, and the parietal portion of the inner lip. *Eripachya* ***vaccina*** is more slender, has a longer anterior siphonal canal, and is ornamented with fewer secondary spirals than the type species, *E. ponderosa*. The holotype of *E.* ***vaccina*** shows no lirae on the outer lip but is broken back too far to be sure that lirae

were not present. Additionally the shape of the parietal portion of the inner lip is undeterminable, as is the presence of a posterior siphonal notch at the suture.

Etymology: The specific name ***vaccina,*** Latin, meaning of cows, refers to the type locality on the north side of Little Cow Creek.

Eripachya ponderosa (Gabb, 1864)

(Figures 49–54)

Neptunea ponderosa Gabb, 1864:88, pl. 18, fig. 38.
Eripachya ponderosa (Gabb): Gabb, 1869:149; Cossmann, 1901:147, fig. 40; Stewart, 1927:425, pl. 20, fig. 9; Wenz, 1941:1185, fig. 3373; Anderson, 1958:172.

Description: Shell of medium size, robust, bucciniform, apical angle of about 80°; spire approximately two-thirds the total height of the shell, with about six plumply convex whorls about twice as wide as high; suture undulating, and appressed; siphonal neck broad, barely longer than the spire, with a low well-developed fasciole. Sculpture of narrow spiral cords and strong collabral ribs; five or six primary spiral cords on penultimate whorl, 15 on body whorl and neck, low, flat, narrow, each bordered by graded sets of finer ribs; ten, moderately sharp-crested collabral ribs on early whorls, becoming broader, well rounded on body whorl, about as wide as interspaces, diminishing anteriorly to the periphery, disappearing on base of whorl. Aperture eye-shaped, broad posteriorly with a small narrow posterior channel at the suture, attenuated anteriorly; siphonal canal moderately narrow, short, tip flexed backward and to left; inner lip smooth, without folds, parietal portion thin, rounded; columellar portion thicker, nearly straight, with a free edge forming a narrow, shallow umbilical chink anterior to the fasciole; outer lip thin, lirate within.

Lectotype: ANSP cat. no. 4186, here designated.

Hypotype: CASG cat. no. 53344.01 (= CSMB cat. no. 12793) from Tuscan Springs, Tehama Co., California.

Dimensions: See Table 6.

Type locality: Tuscan Springs, on Little Salt Creek, Tehama Co., California.

Distribution: A rare species, known predominantly from the type locality. Some small poorly preserved specimens from the Schultz Member of the Williams Formation in the Santa Ana Mountains (UCLA loc. 7199), Orange Co., may be this species.

Geologic age: Campanian.

Remarks: Stewart (1927) figured ANSP cat. no. 4186 and referred to it as the holotype because he considered it to be the specimen Gabb (1864) had figured. Gabb, however, did not designate type specimens, and he mentions more than one specimen, but other specimens in the box with Stewart's figured specimen were "*Fulgur*" *hilgardi* White, 1889. Gabb did not differentiate "*Fulgur*" *hilgardi* from *Eripachya ponderosa,* and his specimens of *E. ponderosa* from Pentz are apparently "*F.*" *hilgardi.* As Stewart (1927) did in several instances designate lectotypes, his reference to ANSP 4186 as holotype is an error and cannot be taken as designation of the lectotype. To avoid possible confusion, Stewart's figured specimen ANSP 4186 is therefore herein designated the lectotype.

Table 6

Measurements (mm) of *Eripachya* ***vaccina*** sp. nov. and *E. ponderosa* (Gabb, 1864).

	H	D	Hp	Dp	Ha	A	R	Dp/Hp
E. vaccina								
LACMIP 11548	33.0*	17.5	6.4	11.7	12.0*	49°	8	1.8
LACMIP 11549	24.7*	14.3	5.5	9.0	12.8	46°	8	1.6
E. ponderosa								
CAS 5334401	36.0*	28.7	9.0	14.6	12.0*	77°	11	1.6
UCLA 28733**	34.6	23.2†	9.6	12.8	13.5	60°†	11	1.3

* Specimen incomplete; † specimen crushed; ** plastercast of ANSP 4186. Abbreviations decrypted in Introduction.

Eripachya ponderosa differs from *E.* ***vaccina*** in being stouter, having a shorter anterior canal, and having one more secondary spiral thread in each interspace.

Eripachya ponderosa of Dailey & Popenoe (1966) is early Maastrichtian in age, lacks axial sculpture, and is an undescribed species.

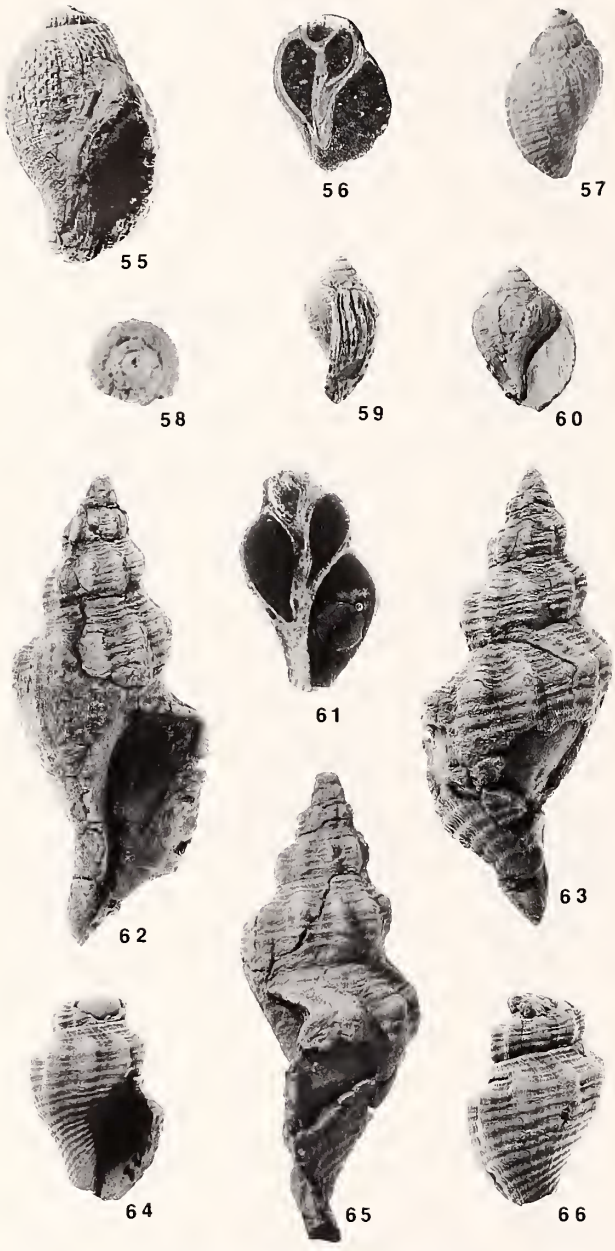
Family Melongenidae Gill, 1871

Genus *Palaeatractus* Gabb, 1869

Type species: By monotypy, *Palaeatractus crassus* Gabb, 1869 from the Turonian of California.

Diagnosis: Small, thick-shelled, pyriform, ornately sculptured melongenids with a slightly twisted columella, simple outer lip, and thick inner lip.

Discussion: These are small shells, considerably smaller than such forms as *Pyrifusus* Conrad, 1858, or *Sycostoma* Cox, 1931, with which Wenz (1941) has associated *Palaeatractus.* The genus is, however, similar in overall shape to these larger forms but has stronger sculpture and a more bent canal than *Sycostoma,* and lacks the subsutural welt and concave band of *Pyrifusus.* The sculpture and shape of *Palaeatractus* recall that of the pseudolivine *Pegocomptus* Zinsmeister, 1983, and the volute *Volutocorbis* (*Retipirula*) *crassatesta* (Gabb, 1869) (Zinsmeister, 1977), but *Palaeatractus* has no pseudolivine groove on the body whorl, no folds on the columella, and has finer sculpture.



Explanation of Figures 55 to 66

Unless otherwise indicated, figures are ×1; specimens coated with ammonium chloride, except as noted.

Figures 55–60. *Palaeatractus crassus* Gabb, 1869. Figure 55: LACMIP cat. no. 11550, from LACMIP loc. 10744, neotype, aperture, ×3. Figure 56: LACMIP cat. no. 11552, from LACMIP loc. 10744, hypotype, section showing lack of folds on columella, ×3, uncoated. Figures 57, 58: LACMIP cat. no. 11551, from LACMIP loc. 10744, hypotype; Figure 57, back, ×3; Figure 58, apical view, ×3. Figures 59, 60: LACMIP cat. no. 11553, from UCLA loc. 4214, hypotype; Figure 59, right side; Figure 60, aperture.

Figures 61–66. ***Saturnus dubius*** (Packard, 1922). Figure 61: LACMIP cat. no. 11556, from LACMIP loc. 10079, section showing lack of folds on columella, hypotype, uncoated.

Table 7

Measurements (mm) of *Palaeatractus crassus* (Gabb, 1869).

	H	D	Hp	Dp	Ha	A	Dp/Hp
LACMIP 11550	10.9*	6.5	1.9	3.5	2.3*	68°	1.8
LACMIP 11551	7.8	4.4	1.4	2.6	2.5	66°	1.9
LACMIP 11552	6.5	4.9	—	—	—	—	—
LACMIP 11553	20.0*	19.6	2.8	5.6	4.7	86°	2.0

* Specimen incomplete. Abbreviations decrypted in Introduction.

Palaeatractus crassus Gabb, 1869

(Figures 55–60)

Palaeatractus crassus Gabb, 1869:148, pl. 26, fig. 26; Cossmann, 1901:82, text fig. 24; Wenz, 1941:1222, fig. 3476.

Diagnosis: Small pyriform shells with a low spire, thick shell, slightly twisted columella, simple outer lip, incrusted inner lip, and a strong, overall sculpture of squarish nodes.

Description: Shell small, pyriform, thick; spire low; whorls five, rounded; suture impressed. Surface marked by prominent, straplike spiral ribbons, crossed by irregular axial ribs or lines; axial ribs variable in size, number, and disposition, but generally of nearly even distribution, producing squarish nodes or tubercles at intersections with spiral ribbons; interspaces showing numerous fine growth lines. Aperture broad in middle, acute posteriorly, extended anteriorly into moderate and slightly twisted canal; outer lip simple; inner lip thick, expanded roundly onto body whorl, extending adapically beyond aperture, with a well defined margin; columella without folds.

Neotype: LACMIP cat. no. 11550. Stewart (1927) was unable to find Gabb's specimens of this species. In their absence, a neotype is herein chosen from LACMIP loc. 10744 (= CIT 1255).

Hypotypes: LACMIP cat. nos. 11551–11552 from LACMIP loc. 10744 (= CIT loc. 1255), French Creek, north of Swede Basin; 11553 from UCLA loc. 4214, Little Cow Creek, Shasta Co., California.

Dimensions: See Table 7.

Original type locality: From the Shasta Group, from a canyon in the foothills, a mile (1.6 km) south of the road from Colusa to the Sulphur Springs near the eastern margin of the Coast Range, Colusa County, California.

←

Figures 62, 63, 65: LACMIP cat. no. 11554, from LACMIP loc. 10079, hypotype; Figure 62, aperture; Figure 63, back; Figure 65, right side. Figures 64, 66: LACMIP cat. no. 11555, from LACMIP loc. 10079, hypotype; Figure 64, aperture; Figure 66, back. Photographs 55, 56, 61–64 by Susuki; 57–60, 65 by De Leon.

Locality of the neotype: LACMIP loc. 10744, French Creek, north of Swede Basin, Shasta Co., California.

Distribution: Redding Formation, Frazier Siltstone Member and near the base of the Melton Sandstone Member, Swede Creek Valley, Redding area, Shasta Co.; Great Valley Series, Colusa Co., California. ANDERSON (1958: 26) listed this species from the second conglomerate above the base of the Pacheco Group on Bear Creek, Colusa Co., but the specimens have not been found at either the California Academy of Sciences or the University of California, Berkeley, Museum of Paleontology.

Geologic age: Turonian.

Remarks: The sculpture of squarish, flat nodes is distinctive. Weathering causes the nodes to become pitted and produces a more ornate, pseudocancellate effect (Figure 55).

Although GABB (1869) indicated that his lot of fossils from south of the road from Colusa to the Sulphur Springs, Colusa County was from the Shasta Group, which is of Early Cretaceous age, this species has not been found associated with others of Early Cretaceous age and is present in beds of Turonian age in the Redding area. ANDERSON (1938:131) interpreted Gabb's locality to be in the first range of foothills on the west side of the Sacramento Valley and south of the road between Colusa and Wilber Springs. He referred this locality to the younger "Chico" beds rather than the older "Shasta" strata. We have not seen any collection that might be from this vicinity, and there is no record of any such collection in the literature. The possibility that a collector might stumble upon this locality and provide topotype or near topotype specimens cannot be ruled out, but the probability that the Redding area specimens are correctly determined is very large. The selection of this neotype provides additional characteristics for recognizing the genus and the species, and for classifying the genus.

COSSMANN (1901) referred three species to *Palaeatractus*: *P. minimus* (Hoeninghaus *in* Goldfuss, 1844) and *P. roemeri* Holzapfel, 1888, from Vaals, Nederlands, "near Aix-la-Chapelle" = Aachen; and "*Voluta*" *rhomboidalis* Zekeli, 1852, from Gosau, Austria. ZEKELI's (1852) figure of "*V.*" *rhomboidalis* (pl. 14, fig. 9) has a more angular whorl profile, less twist to the anterior canal, and lacks the expanded, thickened inner lip of *P. crassus*. STOLICZKA's (1867: 120, pl. 10, fig. 21, 21a) "*V.*" *rhomboidalis* from the Arrialoor Group (Campanian-Maastrichtian) of southern India has a more rounded whorl profile similar to that of *P. crassus,* and may not be Zekeli's species. The Indian form also does not show the expanded demarked inner lip of *P. crassus,* and Stoliczka suggested that in "*V.*" *rhomboidalis* the sculpture diminishes with maturity, which is not true for *P. crassus.* None of these is a convincing *Palaeatractus.*

GABB (1869:148) gave the dimensions of his figured specimen as "Length .62 inch [=16 mm]; width .45 inch [=11.43 mm]; length of aperture .5 inch" [=12.7 mm]; but he drew a size bar (GABB, 1869:pl. 26, fig. 26) 0.8 inch (=20.32 mm) long. WENZ (1941:1223, Abb. 3476) reprinted Gabb's figure, which is 39 mm (=1.5 inches) high, and more than twice Gabb's described height but less than two times his diagrammed height, as being 1/1. Three of the four specimens from Swede Basin in the Redding area are small (6.5 to 10.9 mm high) and close to the height(s) indicated by GABB (1869), but one is larger (20.0 mm high). This specimen, although incomplete and larger than Gabb's size bar, is considerably smaller than Gabb's (or Wenz') figure. Size range of the Redding specimens is probably representative of the species.

The specimen from CASG loc. 1552, north end of the Shale Hills in Antelope Valley, Kern Co., California, identified by ANDERSON (1958:58) as *Palaeatractus crassus* is not this species, but is instead a volute resembling *Konistra biconica* (ANDERSON, 1958). Although ANDERSON (1958) suggested that these beds were of Coniacian age, MATSUMOTO (1960:80) indicated that they are late Campanian-early Maastrichtian in age.

Saturnus Saul & Popenoe, gen. nov.

Type species: *Siphonalia dubius* Packard, 1922, from the Turonian of Southern California.

Diagnosis: Shell fusiform, spire fairly high; whorls angulately shouldered posteriorly with a moderate ramp. Growth lines prosocline at suture, strongly sinused at shoulder, and broadly arcuate across flank. Sculpture of spiral ribbons over riding collabral ribs; collabral ribs strong, rounded, accentuated by nodes at shoulder, dying out above and below. Aperture notched posteriorly at shoulder, siphonal canal curved to left; outer lip smooth; columella smooth; inner lip well marked and forming a narrow pseudoumbilicus at fasciole.

Discussion: ***Saturnus*** resembles *Deussenia* Stephenson, 1941, from the Late Cretaceous of the Gulf Coast, but lacks a subsutural collar, having only a subsutural welt. The posterior end of the aperture makes a broad angle rather than a narrow channel as in *Deussenia.* Although the notch in the growth line at the shoulder is suggestive of a turrid, and ***Saturnus*** bears some resemblance to *Knefastia* Dall, 1919, the shoulder notch of ***Saturnus*** is shallow and its growth line is similar to that of melongenids.

The genus is named for the Roman god of agriculture, ***Saturnus,*** and is of masculine gender.

Saturnus dubius (Packard, 1922)

(Figures 61–66)

Siphonalia dubia PACKARD, 1922:431, pl. 35, fig. 5.

Diagnosus: As for the genus.

Description: Medium-sized fusiform shells with a spire about one-third total shell height; pleural angle about 47°; protoconch unknown; suture appressed with a slight subsutural welt; body constricted posteriorly to form a shallow

Table 8

Measurements (mm) of ***Saturnus dubius*** (Packard, 1922).

	H	D	Hp	Dp	Ha	Hs	A	R	Dp/Hp	Hp/Hs
LACMIP 11554	62.8	25.8	12.3	17.8	21.0	8.5	47°	10	1.4	1.4
LACMIP 11555	27.5*	14.8	7.6	13.7	—	4.9	44°	9	1.8	1.6
LAMCIP 11556	30.4*	20.7	—	—	—	—	46°	—	—	—

* Specimen incomplete. Abbreviations decrypted in Introduction.

ramp, slightly swollen below nodose shoulder, and tapering anteriorly. Sculpture of strong, broad, rounded collabral ribs, about 10 per whorl, arising at shoulder and dying out on flank, all overridden by flat-topped spiral ribbons narrower than interspaces, four or five ribbons on whorl flanks of spire, at least 12 on body whorl flank, and about six on ramp. Growth lines prosocline at suture, becoming strongly opisthocline on ramp, sinused at shoulder, becoming orthocline over periphery and base. Aperture rather ear-shaped with a broad posterior notch and a stronger notch at shoulder; anterior canal elongate, slightly twisted, and inclined to the left; inner lip moderately thick, well demarked, rounded parietally, forming an elongate chink-like pseudoumbilicus along fasciole.

Holotype: UCBMP cat. no. 12304.

Hypotypes: LACMIP cat. no. 11554–11556 from LACMIP loc. 10079 (= CIT loc. 1164), south side Silverado Canyon, Santa Ana Mts., Orange Co., California.

Type locality: "from the Chico of the Santa Ana Mountains, Orange Co., California" (Packard, 1922).

Dimensions: See Table 8.

Geologic age: Turonian.

Distribution: Known from several localities, all near the top of the Baker Canyon Member or the base of the overlying Holz Shale Member, Ladd Formation, Santa Ana Mountains, Orange Co., California.

Remarks: Packard's (1922:431) specimen was imprecisely located, and he was unable to determine the horizon of this species. It resembles *Deussenia ripleyana* Harbison, 1945, from the Ripley Formation of the Gulf Coast but is higher spired, has stronger and fewer collabral ribs, and a fasciole with a very narrow pseudoumbilicus. The aperture has a broader posterior notch and a stronger, wider shoulder notch.

Family Fasciolariidae Gray, 1853

Subfamily Fasciolariinae Gray, 1853

Genus *Drilluta* Wade, 1916

Type species: *Drilluta communis* Wade, 1916, by original designation, from the Maastrichtian of Tennessee.

Diagnosis: Rather slender fusiform shells with a spire about half total shell height. Whorls posteriorly constricted to a roughened subsutural collar. Sculpture usually dominated by strong collabral transverse ribs; spiral sculpture well developed on basal slope, less frequently on periphery. Aperture notched posteriorly, siphonal canal of moderate length and slightly inclined to left. Inner lip callus thin; columella with a strong plait anterior to one or two weaker folds (Sohl, 1964:205).

Discussion: Wade (1916), Stephenson (1941), and Pilsbry & Olsson (1954) considered *Drilluta* to belong to the Volutidae, but Wenz (1943:1418) placed it in the Conacea. Sohl (1964:205) considers it close to *Bellifusus* Stephenson, 1941 (type species *Odontofusus curvicostata* Wade, 1926, Maastrichtian, Gulf Coast), and places it in the Fasciolariidae.

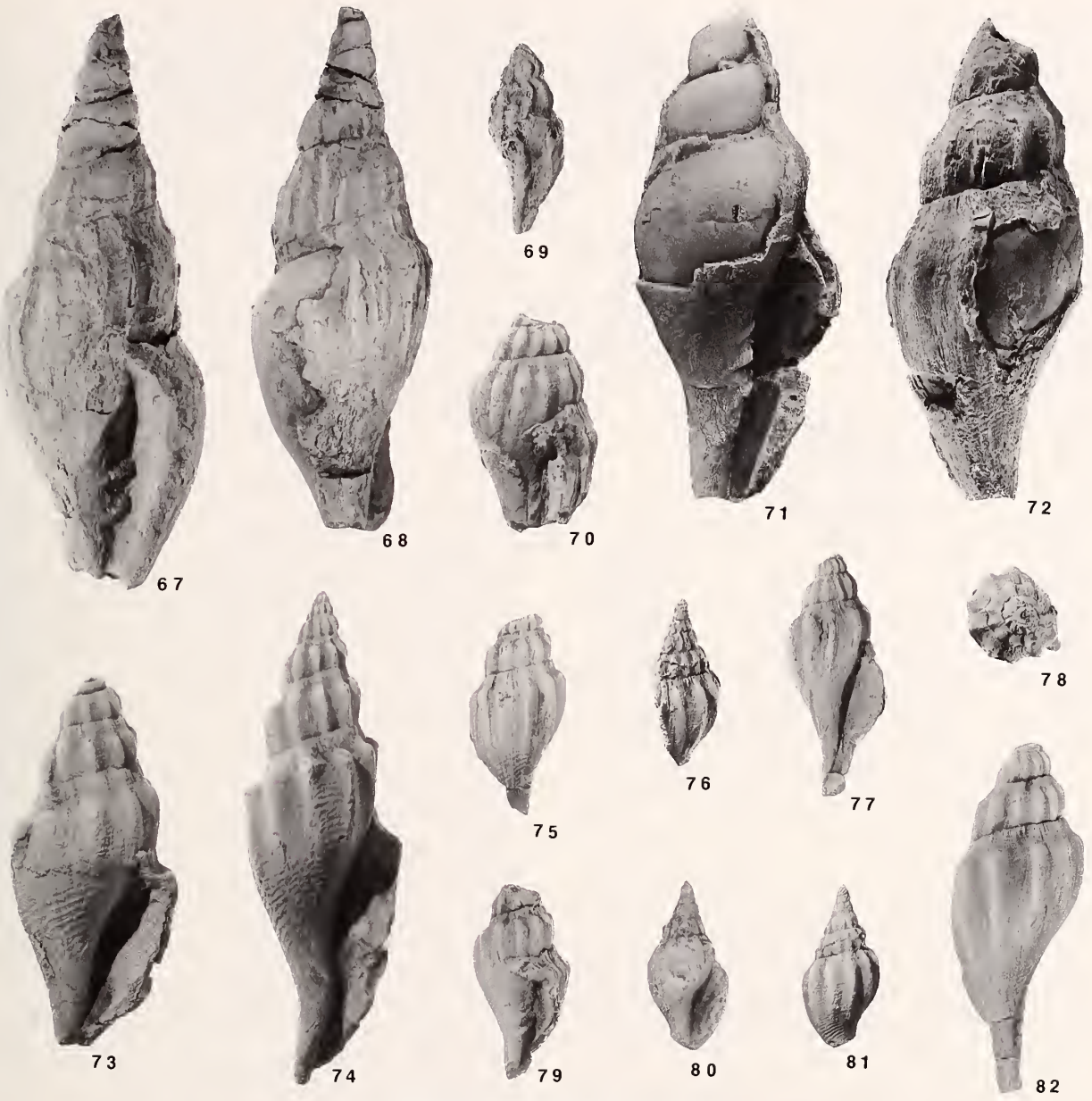
Drilluta jacksonensis (Anderson, 1958)

(Figures 67–72)

Volutoderma? jacksonensis Anderson, 1958:174, pl. 21, fig. 1.

Diagnosis: A large *Drilluta* with a weakly developed subsutural collar, moderately strong shoulder, elongate body whorl, 13 to 18 wide-spaced strong, sigmoidal collabral ribs, and faint spiral sculpture on base of body whorl and siphonal neck. Shoulder at about mid whorl height on spire.

Description: Shell large, elongate fusiform, apical angle about 33°; spire broken but probably approximately of same length as body whorl; whorls of spire about one-third broader than high, with a steeply sloping, moderately broad and very shallowly concave ramp to noded shoulder, shoulder at about mid whorl height, flanks slightly convex; suture sinuous, appressed, with weakly developed, wrinkled subsutural collar; body whorl with a steeply sloping concave ramp to noded shoulder, gently convex lateral areas, and concave gently tapering, moderately long siphonal portion; axial sculpture of 13 to 18 rather widely spaced, collabral ribs to the whorl; ribs concave toward aperture, most strongly developed on shoulder of whorl, diminishing and disappearing rapidly anteriorly, and usually more or less obsolete on the concave ramp; spiral sculpture of close-set, faint, revolving lines usually apparent only on base of body whorl and siphonal neck. Aperture narrow, parietal border of aperture shallowly excavated; columella of medium length, nearly straight, bearing prox-



Explanation of Figures 67 to 82

All specimens coated with ammonium chloride; unless otherwise indicated figures are ×1.

Figures 67–72. *Drilluta jacksonensis* (Anderson, 1958). Figures 67, 68: CAS cat. no. 445.16 from CAS loc. 445, holotype; Figure 67, aperture; Figure 68, left side. Figure 69: LACMIP cat. no. 11584 from LACMIP loc. 10778, hypotype, aperture. Figure 70: LACMIP cat. no. 11562 from LACMIP loc. 10771, hypotype, aperture. Figures 71, 72: LACMIP cat. no. 11557 from LACMIP loc. 10750, hypotype; Figure 71, aperture; Figure 72, back.

Figures 73–82. *Drilluta* ***sicca*** sp. nov. Figure 73: CAS cat. no. 445.31 from CAS loc. 445, holotype, aperture. Figure 74: LACMIP cat. no. 11563 from LACMIP loc. 10903, paratype, aperture. Figures 75, 79: LACMIP cat. no. 11566 from LACMIP loc. 10903, paratype; Figure 75, back view; Figure 79, aperture showing columellar folds.

Figures 76, 80, 81: LACMIP cat. no. 11559 from LACMIP loc. 10810, paratype; Figure 76, right side, ×2; Figure 80, aperture, ×2; Figure 81, back, ×2. Figures 77, 78, 82: LACMIP cat. no. 11565 from LACMIP loc. 10769, paratype; Figure 77, aperture; Figure 78, apical view; Figure 82, left side, ×1.5. Photographs 67–70, 73–82 by De Leon; 71, 72 by Susuki.

Table 9

Measurements (mm) of *Drilluta jacksonensis* (Anderson, 1958) and *D. **sicca*** sp. nov.

	H	D	Hp	Dp	Ha	Hs	A	R	Dp/Hp	Hp/Hs
D. jacksonensis										
CAS 445.16	85.0*	33.9	16.2	23.8	47.0*	8.7	33°	17	1.5	1.9
LACMIP 11557	70.6*	30.0	14.4	23.0	27.9*	7.0	35°	14	1.6	2.1
LACMIP 11558	32.0*	14.8†	7.6	10.8†	—	4.0	32°†	13	1.4	1.9
LACMIP 11562	32.0*	15.0†	7.8	10.0	—	4.0	40°†	14	1.3	2.0
LACMIP 11584	27.8*	11.5	5.0	7.8	11.4	2.7	41°	13	1.6	1.8
*D. **sicca***										
CAS 445.31	56.5*	26.3†	12.8	18.6	25.6	8.9	37°	10	1.4	1.4
LACMIP 11559	12.8*	6.1	1.9	4.0	6.5	1.5	43°	12	2.1	1.3
LACMIP 11560	11.4*	5.6	2.0	—	—	1.2	—	11	—	1.7
LACMIP 11561●	—	—	—	—	—	—	39°	12	—	—
LACMIP 11563	70.0	22.3	11.7	16.0	31.0	9.0	32°	10	1.4	1.3
LACMIP 11564●	54.7*	—	8.4	—	—	5.5	—	—	—	1.5
LACMIP 11565	34.7*	16.0	7.0	11.0	12.5	4.5	41°	11	1.6	1.6
LACMIP 11566	29.2*	14.7	7.5	13.0	—	4.7	38°	12	1.7	1.6
UW 91830	33.7*	13.7	6.5	10.5	14.3	4.5	45°	12	1.6	1.4

* Specimen incomplete; † specimen crushed; ● latex pull. Abbreviations decrypted in Introduction.

imally three oblique prominent revolving folds, anterior fold strongest; no basal fasciole.

Holotype: CASG cat. no. 445.16.

Hypotypes: LACMIP cat. nos. 11557 from LACMIP loc. 10750 (= CIT loc. 1264); 11562 from LACMIP loc. 10771 (= CIT loc. 1209), Salt Creek; 11584 from LACMIP loc. 10778 (= CIT loc. 1195; UCLA loc. 4416), Stinking Creek, Shasta Co., California.

Dimensions: See Table 9.

Type locality: CASG loc. 445, Forty-nine mine, two miles (3.2 km) south of Phoenix, Jackson Co., Oregon.

Distribution: Redding Formation, Bellavista Sandstone Member, Stinking Creek, Melton Sandstone Member, Little Cow Creek area, Shasta Co., California.

Geologic age: Turonian.

Remarks: Although ANDERSON (1958) described this species as lacking spiral sculpture, faint spiral lines are present on the base of the body whorl and siphonal neck. *Drilluta jacksonensis* differs from *D. **sicca*** in having more and narrower collabral ribs, fainter spiral sculpture, and a weaker shoulder that is at about mid whorl on the spire. *Drilluta jacksonensis* has a more inconspicuous subsutural collar than does *D. **sicca*** and than have other species of *Drilluta*. Of three similar Gulf Coast genera, *Drilluta* (large, collared), *Paleopsephaea* Wade, 1926 (type species *P. mutabilis* Wade, 1926, medium sized, not collared), and *Bellifusus* (medium sized, collared), *D. jacksonensis* is most like *Drilluta* in size, shape, and columellar folds. Among Gulf Coast species of *Drilluta, D. jacksonensis* is most similar to *D. communis* (WADE, 1916:459, pl. 23, figs. 5–6; SOHL, 1964: 205, pl. 27, figs. 12–13, 20–22) in size and shape, but has a wider ramp and more poorly developed subsutural collar.

*Drilluta **sicca*** Saul & Popenoe, sp. nov.

(Figures 73–82)

Diagnosis: A volutiform *Drilluta* with moderately developed, wrinkled collar, slightly concave ramp, and 10–12 strongly shouldered, nearly straight collabral ribs per whorl. On spire, shoulder at about two-thirds whorl height.

Description: Shell medium sized, elongate volutiform; apical angle about 40°; spire shorter than body whorl; whorls of spire about one-third broader than high, with a sloping, moderately broad, and very shallowly concave ramp to noded shoulder; shoulder at two-thirds whorl height; flanks rather straight; suture sinuous, appressed with moderately developed, wrinkled subsutural collar; body whorl with concave ramp to noded shoulder, barely convex lateral areas, and concave, gently tapering, moderately long siphonal portion. Sculpture of 10 to 12 rather widely spaced, nearly straight, sharp collabral ribs per whorl, over-ridden by spiral riblets, weak on ramp and shoulder, stronger abapical to the mid-flank. Aperture narrow, parietal border of aperture shallowly excavated; columella bearing two oblique, moderately strong folds, anterior fold stronger, and a faint third, posterior fold; inner lip thin, of moderate width, rounded on the base of the whorl.

Holotype: CASG cat. no. 445.31.

Paratypes: LACMIP cat. nos. 11559–11561 from LACMIP loc. 10810 (= CIT loc. 1207), Dry Creek; 11563 from LACMIP loc. 10771 (= CIT loc. 1209), Salt Creek;

LACMIP cat. no. 11564 from LACMIP loc. 10735 (= CIT loc. 1212), Little Cow Creek; LACMIP cat. no. 11565 from LACMIP loc. 10769 (= CIT loc. 1203), Dry Creek, Shasta Co., California; LACMIP cat. no. 11566 from LACMIP loc. 10903 (= CIT loc. 1622), south of Ashland, Jackson Co., Oregon; UW cat. no. 91830 from UW loc. B5900, Sidney Island, British Columbia.

Type locality: CASG loc. 445, Forty-nine mine, two miles (3.2 km) south of Phoenix, Jackson Co., Oregon.

Dimensions: See Table 9.

Distribution: Unnamed formation, Sidney Island (coll. Peter Ward, 3 September 1992), British Columbia; Hornbrook Formation, near Phoenix, Jackson Co., Oregon; Redding Formation, Bellavista Sandstone Member, Frazier Siltstone Member, and Melton Sandstone Member, Redding area, Shasta Co., California.

Geologic age: Turonian.

Remarks: *Drilluta* ***sicca*** resembles *D. distans* (Conrad, 1860) from the Ripley Formation of the Gulf Coast, but the West Coast form is more strongly shouldered. *Drilluta* ***sicca*** is lower spired, has a more prominent shoulder, has fewer, stronger, straighter collabral ribs, and has stronger spiral riblets than *D. jacksonensis*. *Drilluta* ***sicca*** resembles ***Varens anae*** sp. nov. in overall shape, but ***V. anae*** lacks spiral sculpture and has a broad, straight anterior canal whereas that of *D.* ***sicca*** is slender and twisted.

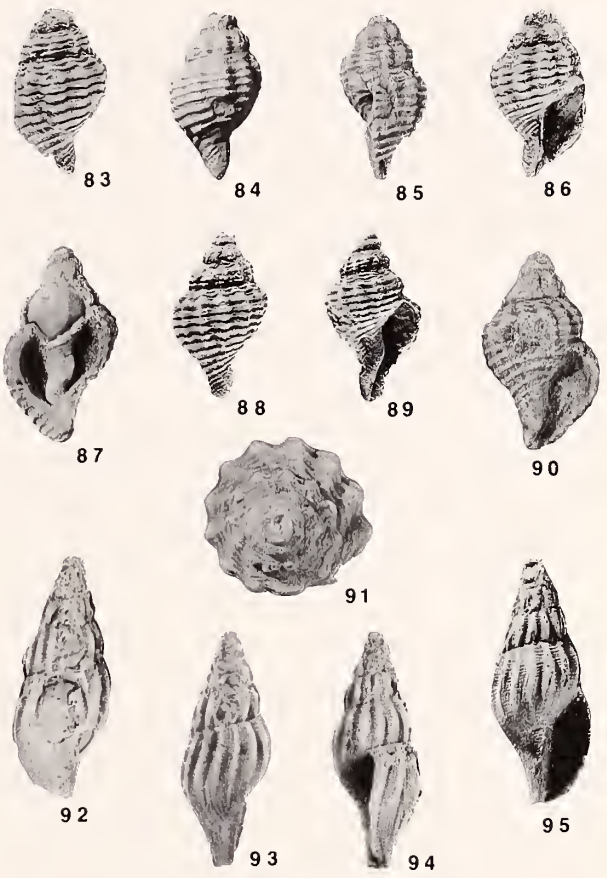
Both *Drilluta* ***sicca*** and *D. jacksonensis* are of late Turonian age at their type locality (MATSUMOTO, 1960:77), but both are also found in the slightly older Bellavista Sandstone Member of the Redding Formation.

Etymology: The specific name refers to the type locality on Dry Creek, ***siccus,*** Latin, meaning dry.

Genus ***Skyles*** Saul & Popenoe, gen. nov.

Type species: ***Skyles salsus*** Saul & Popenoe, sp. nov.

Diagnosis: A medium-sized, broadly fusiform fasciolarid with a moderate spire and broad apical angle; suture impressed and sinuous; last whorl longer than the spire, roundly convex from posterior suture to neck of siphonal canal, constricted basally to form siphonal neck; growth lines and labral profile gently sigmoid, antecurrent at suture, concave aperturally below suture. Sculpture of raised spiral straps and low strong, nearly straight, rounded axial ribs, well developed on posterior half of last whorl. Aperture elliptical with a short, parallel-sided, leftward-bent anterior sinus; inner lip thin, oblique and twisted to the left siphonally, bearing one oblique inconspicuous fold at juncture of canal and aperture; columella twisted to left distally; outer lip thin, transversely lirate at its edge; siphonal fasciole low, broad, enclosing a minute umbilical chink.



Explanation of Figures 83–95

Unless otherwise indicated, figures are ×1; all specimens coated with ammonium chloride.

Figures 83–91. ***Skyles salsus*** sp. nov. Figures 83–86: LACMIP cat. no. 11568 from LACMIP loc. 10735, paratype; Figure 83, aperture; Figure 84, left side; Figure 85, right side; Figure 86, aperture. Figures 87, 90: LACMIP cat. no. 11569 from LACMIP loc. 10735, paratype; back cut away to show columellar fold; Figure 90, aperture. Figures 88, 89, 91: LACMIP cat. no. 11567 from LACMIP loc. 10735, holotype; back view; Figure 89, aperture; Figure 91, apical view, ×2.

Figures 92–94. *Remera* ***vacca*** sp. nov., LACMIP cat. no. 11570 from LACMIP loc. 1446, holotype; Figure 92, back, ×3.5; Figure 93, left side, ×3.5; Figure 94, right side. ×3.5; Figure 95, aperture, ×3.5. Photographs 83, 86, 88, 89, 95 by Susuki; 84, 85, 87, 90–94 by De Leon.

Discussion: ***Skyles*** is similar to *Ornopsis* Wade, 1926 (type species *O. glenni* Wade, 1916, Maastrichtian, Gulf Coast), from which ***Skyles*** differs in having the axial ribs more persistent posteriorly, lacking a concave subsutural band, having coarser, more widely spaced spiral sculpture, and having a shorter siphonal canal. Although the columellar fold of ***Skyles*** is similar to that of *Ornopsis,* the absence of a concave subsutural band in ***Skyles*** gives it a more buccinifform whorl profile.

Table 10

Measurements (mm) of ***Skyles salsus*** sp. nov.

	H	D	Hp	Dp	Ha	A	R	Dp/ Hp
LACMIP 11567	22.4*	12.0	4.0	10.0	9.3	52°	12	2.5
LACMIP 11568	22.0	12.5	4.8	9.8	9.1	62°	11	2.0
LACMIP 11569	26.4	16.0	6.4	11.2	13.0	60°	—	1.8

* Specimen incomplete. Abbreviations decrypted in Introduction.

The genus is named for Scyles, a Scythian king who was beheaded by his brother, and is of masculine gender.

Skyles salsus Saul & Popenoe, sp. nov.

(Figures 83–95)

Diagnosis: As for the genus.

Description: Shell medium sized, broadly fusiform; spire about two-fifths the height of the shell, apical angle 55°; whorls five, evenly convex, about twice as wide as high; suture linear, impressed, and sinuous; last whorl about half as long again as spire, broadly convex from posterior suture to approximately beginning of siphonal canal, thence shallowly concave to anterior tip; growth lines and labral profile gently sigmoid, antecurrent at suture, concave aperturally below suture. Sculpture of evenly spaced, distinct, raised spiral straps separated by interspaces as wide as spirals, numbering 13 or 14 on last whorl, and about 10 low strong nearly straight, rounded axial ribs, well developed on posterior half of whorl, but obsolete on siphonal neck. Aperture elliptical; inner lip covered with a thin callus wash, unevenly excavated parietally, oblique and gently twisted to the left in its siphonal part, bearing one oblique, inconspicuous, laterally compressed fold at juncture of canal and aperture; outer lip incomplete in all specimens at hand, but apparently thin, transversely lirate internally at apertural margin but smooth farther within; columella rather short and twisted to the left distally; siphonal fasciole low, broad, rounded, smooth, enclosing minute umbilical chink.

Holotype: LACMIP cat. no. 11567.

Paratypes: LACMIP cat. nos. 11568–11569 from LACMIP loc. 10735 (= CIT loc. 1212).

Dimensions: See Table 10.

Type locality: LACMIP loc. 10735 (= CIT loc. 1212), Little Cow Creek, two miles (3.2 km) NE of Frazier Corners, Shasta Co., California.

Distribution: Known only from the type locality.

Geologic age: Turonian.

Remarks: ***Skyles salsus*** is described from three specimens. It resembles *Ornopsis glenni* Wade, 1926, the type species of *Ornopsis,* but differs in having the axial ribs persist to the posterior suture, lacking a concave subsutural band, having coarser, more widely spaced and fewer spiral ribs, and having a shorter siphonal canal.

Etymology: The species is named for its type locality on Salt Creek, Latin, ***salsus,*** meaning salted, salty, witty.

Subfamily FUSININAE Wrigley, 1927

Genus *Remera* Stephenson, 1941

Type species: *Remera microstriata* Stephenson, 1941, from the Maastrichtian of the Gulf Coast.

Diagnosis: Medium-sized fusiform shells with the spire more than half total shell height. Whorls flat sided, ornamented by strong collabral ribs and subdued overriding spiral ribbons. Aperture lenticular, angulated posteriorly; siphonal canal moderately long and straight; columella smooth (SOHL, 1964:226).

Discussion: *Remera* is represented by several species from the Gulf and Atlantic coastal plains *Exogyra ponderosa* and *Exogyra cancellata* zones. Specific differentiation within the genus is based, for the most part, on relatively minor differences in convexity of the whorl sides and sinuosity of the collabral ribs, and some species are based upon so little material that comparison is difficult. Some of these species may, with further study, prove to be synonyms (SOHL, 1964:226). *Remera* has not been reported hitherto from the Pacific Coast Cretaceous nor from beds as old as the Turonian.

ERICKSON (1974:207) suggests that *Remera* may be a synonym of *Exilia* Conrad, 1860, type species *Exilia pergracilis* Conrad, 1860, by monotypy, Paleocene, Gulf Coast. STEWART (1927) indicated that *Exilia* has a shallow posterior siphonal notch and placed *Exilia* in the Turridae, where most subsequent workers have left it. BENTSON (1940: 202) was unable to find any indication of a posterior notch and placed it in the Fusininae, but *Exilia* continues to be classed as a brachytomine turrid (*e.g.,* GIVENS, 1974:91). The growth line of *Remera* has a broad posterior sinus like that of other Fusininae. *Remera* has the spire equal to more than half the total shell height, whereas in *Exilia* the spire is relatively shorter, and the aperture is equal to or longer than the spire.

Remera ***vacca*** Saul & Popenoe, sp. nov.

(Figures 92–95)

Diagnosis: A small, short *Remera* with 15 collabral ribs.

Description: Shell small, slender, subfusiform, with rounded whorls and an acute spire; apical angle about 35°;

whorls about six (spire incomplete), gently and evenly convex, wider than high; suture linear and impressed; last whorl slightly less than one-half the height of the shell, evenly but broadly convex, rounding abapically into a straight and rather short anterior canal; growth lines forming a gentle parasigmoid curve, concave on posterior part of body whorl, convex toward aperture anteriorly, aligned nearly with the shell axis. Sculpture of about 15 low, sinuous, round-crested collabral ribs, and numerous, fine, irregularly spaced, incised spiral lines; collabral sculpture dying out at base of body whorl, but spiral lines persisting to anterior end of shell. Aperture elongate-fusiform, pointed posteriorly; inner lip smooth without visible columellar plications or callus, excavated at base of parietal wall; outer lip thin.

Holotype: LACMIP cat. no. 11570.

Type locality: LACMIP loc. 10764 (= CIT loc. 1446), south side Woodman Creek, Millville Quadrangle, Shasta Co., California.

Dimensions: See Table 11.

Distribution: Known only from the type locality approximately 152 m above the base of the Bellavista Sandstone Member of the Redding Formation.

Geologic age: Turonian.

Remarks: *Remera* ***vacca*** differs from all species previously assigned to this genus in being shorter. The spire does, however, make up more than half of the total shell height. This species is described from one well-preserved, nearly complete specimen, lacking only the apical and anterior sinus tips. If it is an adult, it is decidedly small for the genus.

Etymology: The species is named for its type locality in Little Cow Creek valley, Latin, ***vacca,*** meaning cow.

Table 11

Measurements (mm) of *Remera* ***vacca*** sp. nov.

	H	D	Hp	Dp	Ha	A	La	Dp/ Hp
LACMIP 11570	9.4*	4.0	1.9	2.8	4.9*	35°	4.2	1.5

* Specimen incomplete. Abbreviations decrypted in Introduction.

Superfamily VOLUTACEA Rafinesque, 1815

Family VOLUTIDAE Rafinesque, 1815

The Late Cretaceous seems to have been marked by an efflorescense of related large volutes in all parts of the world (DALL, 1907). In Dall's view, certain morphological types are repeated among the species making up the volute group in each fauna. The disparate morphologies of each local group are thus more closely related than they are to the forms they mimic of other areas. Dall, therefore, proposed taxa and generic groupings with strong geographic control, but others have chosen to group the species by morphological similarities. Although such incompatible methods have resulted in a classification of Cretaceous volutes that needs thorough revision, such is not attempted in this paper. Modern volutes have been reviewed by WEAVER & DU PONT (1970), who followed the classification of PILSBRY & OLSSON (1954), which divides the Volutidae into 12 subfamilies. PONDER & WARÉN (1988) combined some of the subfamilies of Pilsbry & Olsson, but added others and divided the Volutidae into 10 subfamilies. The least satisfactory of these is the Pholidotominae Cossmann, 1896, queried by Ponder & Warén, in which they questionably submerge Volutoderminae Pilsbry & Olsson, 1954. The four genera of Cossmann's Pholidotominae—*Pholidotoma* Cossmann, 1896, *Beisselia* Holzapfel, 1889, *Rostellites* Conrad, 1855, and *Gosavia* Stoliczka, 1866—have only the posterior growth-line sinus in common. *Pholidotoma* and *Beisselia* have a smooth columella and are probably not volutes. Cossmann's *Rostellites* includes *Volutoderma* Gabb, 1877, *Volutomorpha* Gabb, 1877, and *Longiconcha* Stephenson, 1941, among others that PILSBRY & OLSSON (1954) place in Volutoderminae. PILSBRY & OLSSON (1954:29) suggest that *Gosavia* may be a turrid, but except for its growth line, its adult shell is similar to that of *Volutocristata* Gardner & Bowles, 1934, which Pilsbry & Olsson have included in Atheletinae Pilsbry & Olsson, 1954. *Volutocristata* has been shown to be a junior synonym of *Lyrischapa* Aldrich, 1911 (GIVENS, 1979), which is usually classed in the subfamily Fulgorarinae Pilsbry & Olsson, 1954.

Subfamily VOLUTODERMINAE Pilsbry & Olsson, 1954

The geologically oldest members of this subfamily have a marked posterior sinus to the growth line. The sinus is commonly on the shoulder in Cenomanian forms, but is generally broader, shallower, and closer to the suture in Maastrichtian forms. Sculpture may be strongly cancellate or *Ficus*-like, formed by the intersection of strong ribs and spirals.

Genus *Carota* Stephenson, 1952

Type species: By original designation, *Carota robusta* Stephenson, 1952, Cenomanian, from Woodbine Formation, Texas.

Diagnosis: Medium to large volutids with medium height spire; relatively large, strongly tilted protoconch; elongated, gracefully curved body whorl; coarsely noded shoulder angle; a deep notch at intersection of shoulder angle with outer lip; two or three coarse folds on columella; and a relatively fine pattern of spiral ornamentation.

Discussion: *Carota, Gosavia,* and *Rostellaca* Dall, 1907, have similar sculpture and growth line. *Gosavia* was assigned by STOLICZKA (1867) to the Conidae because of its shape and by COSSMANN (1896) and PILSBRY & OLSSON (1954) to the Turridae, presumably because of its growth line, but it has been accepted as a volute by many (*e.g.,* DALL, 1907; WENZ, 1943). *Gosavia* has five to six columellar folds rather than the two or three of *Carota. Rostellaca* has three columellar folds, is shaped more like *Carota,* and has similar but rougher sculpture (DALL, 1907). *Rostellaca* differs mainly in having the posterior notch nearer the suture, a thicker, wider inner lip, and a strong twist to the end of the anterior siphon.

In *Carota,* STEPHENSON (1952) included, in addition to four species from the Woodbine Formation of Texas, *Volutoderma? venusta* Stephenson, 1936, from Banquereau Bank, off the east coast of Nova Scotia, and *Rostellites dalli* Stanton, 1893, from the "*Pugnellus* sandstone" of Turonian age, Huerfano Park, Colorado. The following two Pacific Slope species, *Scobinella dilleri* and *Cordiera mitraeformis,* herein placed in *Carota,* have a posterior notch in the outer lip at the shoulder similar to that of *Carota.* This characteristic may prove to be an evolving trait. The relatively deep posterior notch distant from the suture is present in Cenomanian and Turonian volutes, a shallower notch closer to the posterior suture is common in later Cretaceous volutes, and most Cenozoic volutes have no more than a vestige of a notch against the suture.

The pattern of the columellar folds differs on the two Pacific Slope species: *Carota dilleri* (White, 1889) has three nearly equal, equally spaced folds as in the type species, *Carota robusta*; but in *C.? mitraeformis* (Gabb, 1869) the two posterior folds are closer together and the two anterior folds are stronger. Although fold number, placing, and strength vary among species assigned to *Carota* by STEPHENSON (1952), none has the same pattern as *C.? mitraeformis.*

Carota dilleri (White, 1889)

(Figures 96–101, 106, 107)

Scobinella dilleri WHITE, 1889:25, pl. 4, figs. 1–3; STANTON, 1895:19.
Volutoderma (*Rostellinda*) *dilleri* (White): DALL, 1907:10.
"*Scobinella dilleri*" White: STEWART, 1927:410.
Volutoderma dilleri (White): ANDERSON, 1958:175.
Rostellinda dilleri (White): JONES, SLITER & POPENOE, 1978: xxii.9, pl. 1, fig. 7.

Diagnosis: A slender, high-spired *Carota* with strongly shouldered, straight axial ribs, regular straplike spiral cords, and a relatively shallow growth-line notch at the shoulder.

Description: Shell of medium size, fusiform, with about seven volutions; whorls of the spire angulately convex; last whorl elongate, shouldered posteriorly, its greatest diameter near its shoulder, concave posterior to shoulder and broadly convex anterior to it, tapering anteriorly to a short siphonal canal; growth line opisthocline on ramp, strongly notched at shoulder, barely convex across flank. Spiral sculpture of coarse, raised, revolving lines or small ridges, about 17 or 18 on the last whorl, broader about middle of whorl, narrower anteriorly and on the siphonal neck, and obsolete on subsutural ramp; axial ribs present on all whorls, strongest at shoulder, usually nine on last whorl. Aperture narrow, nearly parallel-sided; anterior canal narrow, curved, flexed gently to the left; outer lip thin, with a broad sinus between suture and shoulder, broadly convex between shoulder and anterior siphon; columella with three strong folds of approximately equal size and spacing, strengthening interiorly; inner lip with pad of callus at posterior margin, adjacent to the anal gutter.

Syntypes: USNM cat. no. 20123 (3 specimens).

Hypotypes: LACMIP cat. nos. 10806 (= UCLA 59444, JONES *et al.,* 1978:fig. 7), 11571–11572, 11616; all from

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Explanation of Figures 96 to 120

Unless otherwise indicated, figures are ×1; specimens coated with ammonium chloride, except as noted.

Figures 96–101, 105–107. *Carota dilleri* (White, 1889). Figures 96–98, 107: LACMIP cat. no. 11571 from LACMIP loc. 10735, hypotype; Figure 96, aperture; Figure 97, back; Figure 98, right side; Figure 107, posterior growth line sinus at the shoulder, ×2. Figure 99: LACMIP cat. no. 11616 from LACMIP loc. 10735, hypotype, aperture. Figures 100, 101: LACMIP cat. no. 10806 from LACMIP loc. 10735, hypotype; Figure 100, outer lip broken back, showing columellar folds; Figure 101, back. Figure 106: LACMIP cat. no. 11572 from LACMIP loc. 10735, hypotype, showing columellar folds, back view, uncoated.

Figures 102–105, 108–113: *Carota? mitraeformis* (Gabb, 1869). Figures 102–104, 113: LACMIP cat. no. 11573 from LACMIP loc. 10769, hypotype; Figure 102, aperture; Figure 103, back; Figure 104, right side; Figure 113, apical view. Figures 105, 108: LACMIP cat. no. 11618 from LACMIP loc. 10789, hypotype; Figure 105, left side; Figure 108, aperture. Figure 109: LACMIP cat. no. 11617 from LACMIP loc. 10789, hypotype, posterior growth line sinus at the shoulder, ×2. Figure 110: LACMIP cat. no. 11574 from LACMIP loc. 10769, hypotype, section showing columellar folds, uncoated. Figures 111, 112: LACMIP cat. no. 10805 from LACMIP loc. 10789, hypotype; Figure 111, back; Figure 112, aperture.

Figures 114–120. ***Konistra*** *biconica* (Anderson, 1958). Figures 114–116, 120: CAS cat. no. 61935.01 from CAS loc. 61935, holotype; Figure 114, apical view; Figure 115, left side; Figure 116, right side; Figure 120, aperture. Figures 117–119: LACMIP cat. no. 11619 from LACMIP loc. 10789, hypotype; Figure 117, left side; Figure 118, aperture; Figure 119, posterior portion of growth line, ×2. Photographs 96, 97, 100–103, 106, 110–112 by Susuki; 98, 99, 104, 105, 107–109, 113–120 by De Leon.


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Table 12

Measurements (mm) of *Carota dilleri* (White, 1889) and *Carota? mitraeformis* (Gabb, 1869).

	H	D	Hp	Dp	Ha	Hs	A	R	Dp/Hp	Hp/Hs
Carota dilleri										
LACMIP 11571	49.0*	20.5	7.3	13.0	15.0*	3.0	49°	9	1.8	2.9
LACMIP 11572	45.0	—	6.7	—	—	3.3	41°	—	—	2.0
LACMIP 11616†	49.0*	18.8	7.2	12.6	13.5	3.4	53°	8	1.8	2.1
UCLA 59444	37.8*	20.4	—	—	—	—	—	8	—	—
Carota? mitraeformis										
MCZ 21856**	17.0*	9.5	—	—	—	—	—	—	—	—
LACMIP 11573	38.2	18.2	4.2	10.0	10.0	1.6	61°	23	2.4	2.6
LACMIP 11574	41.5*	27.0	—	—	—	—	—	—	—	—
LACMIP 11617	36.0*	18.0	4.7	10.0	7.0*	1.7	67°	19	1.9	2.8
LACMIP 11618	46.8*	20.4	4.5	12.0	8.0*	1.8	68°	16	2.7	2.5
UCLA 58445	34.0	16.4	4.9	9.4	10.0	2.8	59°	23	1.9	1.8

* Specimen incomplete; † specimen crushed; ** measurements *fide* STEWART, 1927. Abbreviations decrypted in Introduction.

LACMIP loc. 10735 (= CIT 1212), Little Cow Creek, 2 miles (3.2 km) NE of Frazier Corners, Shasta Co., California.

Dimensions: See Table 12.

Type locality: "Little Cow Creek valley, 18 miles (29 km) east of Redding, Shasta Co." (White, 1889).

Distribution: Nanaimo Group, unnamed formation of Sydney Island (Canada Geol. Surv. loc. 85511 and UW loc. 85900), British Columbia; Hornbrook Formation, Osburger Gulch Sandstone Member, Jackson Co., Oregon, and Siskiyou Co., California; Redding Formation, Frazier Siltstone Member above the horizon of *Romaniceras* (*Yubariceras*) *deverioide* (de Grossouvre, 1889), vicinity of Little Cow Creek, Shasta Co.; Gas Point Formation, Ono area, Shasta Co., California; Valle Formation, Upper Member, Cedros Island, Baja California, Mexico.

Geologic age: Early to late Turonian.

Remarks: DALL (1907) referred this species to *Rostellinda* Dall, 1907 (type species *Volutoderma* (*Rostellinda*) *stoliczkana* Dall, 1907, from the Trichinopoly Group of Southern India), a subgenus of *Volutoderma* Gabb, 1877. However, in characterizing *Rostellinda,* DALL (1907:6) says "the sinus near the suture," and neither he nor STOLICZKA (1867:87) mentions a notch at the shoulder that would produce a posterior emargination to the growth line similar to the posterior sinus of turrids. DALL (1907) based the type species of *Rostellinda, V.* (*R.*) *stoliczkana* Dall, 1907, upon figures of STOLICZKA (1867:pl. 7, figs. 6, 7 as *Fulgoraria elongata* d'Orbigny, 1843), and he assigned the nine specimens figured by STOLIZCKA (1867:pl. 7) as *F. elongata* to five new species of *Rostellinda.* On none of these figures is a posterior growth-line emargination indicated at or near the shoulder. Stoliczka also figured and described *Gosavia indica* Stoliczka, 1867, a species which like the type species of *Gosavia* Stoliczka, 1865, *Gosavia squamosa* (Zekeli, 1852), has a posterior notch at the shoulder and a resultant emargination of the growth line. WHITE (1889) had originally described *Carota dilleri* as a *Scobinella* Conrad, 1848, family Pleurotomidae, a placement doubtless suggested by the posterior growth line emargination. Dall either overlooked this characteristic of the growth line or did not consider it of systematic importance in reassigning *C. dilleri* to *Rostellinda.*

Figures of *Rostellaca zitteliana* (Holzapfel, 1888), type species of *Rostellaca* Dall, 1907, clearly show a posterior notch and emarginated growth line, but the notch and emargination are closer to the suture than in *C. dilleri.* DALL (1907) included four species from the Aachen chalk in *Rostellaca* which he characterized as having a "rougher sculpture, with nodulation of the intersections, the axial and spiral ridges more nearly equal in strength, the shell smaller, the shoulder less emphasized, and the posterior sinus less conspicuous."

Carota dilleri is similar to the type species *C. robusta* Stephenson, 1952, in overall shape and sculpture. *Carota dilleri* has a slightly higher spire, more regular spiral ribs, and a slightly shallower posterior siphonal notch than does *C. robusta. Carota dilleri* bears a greater resemblance to *C. robusta* than it does to *C. mitraeformis. Carota dilleri* differs from *C. dalli* STANTON, 1893 (p. 156, pl. 33, figs. 11–13), which is also of Turonian age, in having higher whorls and fewer axial ribs.

The growth line of *Volutoderma* (*Rostellinda*) sp. of YABE & NAGAO, 1928 (p. 95, pl. 17, fig. 16) Cenomanian or Turonian, from the Mikasa Formation, Horomui area of Hokkaido, is not illustrated. The specimen is incomplete, and may not be a volute. But the growth line on *Volutoderma* (*Rostellinda*) sp. of YABE & NAGAO, 1925 (p. 122, pl. 29, fig. 13, 13a, b) Late Cretaceous (*fide* HAYAMI & KASE, 1977:65, stage unknown), Cape Khoi beds in Alexandrovsk area of north Saghalin is described as being sinused on the shoulder, and the illustrated growth line

(pl. 29, fig. 13b) is similar to that of *C. dilleri* and *C.? mitraeformis*. Unfortunately although suggestive of *Carota*, the specimen of YABE & NAGAO, 1925, is incomplete and the presence of columellar folds undetermined.

Both STANTON (1895) and STEWART (1927) considered *C. dilleri* to be similar to *Carota mitraeformis* (Gabb, 1869), and Stewart suggested that the latter species is the immature form of "*Scobinella*" *dilleri*. The two species are distinct, even in immature individuals, and apparently had different substrate preferences. At Redding, *C. dilleri* is common in the sandier facies of the Frazier Siltstone, but *C. mitraeformis* is found in the Bellavista Sandstone Member. *Carota dilleri* has fewer and stronger axial ribs, a higher and more strongly stepped spire, straighter inner lip, less strongly convex outer lip, stronger more equally developed and spaced columellar folds, a broader and more wrinkled whorl shoulder, and a callus pad on the posterior inner lip that is lacking in *C. mitraeformis*.

HAGGART (1991:A161) reports *Tragodesmoceras ashlandicum* Anderson, 1902, from Hamley Point, Sydney Island, British Columbia, and infers an early or mid-Turonian age for these deposits. *Carota dilleri* occurs above *Romaniceras* (*Yubariceras*) *deverioide* in the Redding area and thus probably ranges through most of the Turonian.

Carota? mitraeformis (Gabb, 1869)

(Figures 102–105, 108–113)

Cordiera mitraeformis GABB, 1869:153, pl. 26, fig. 32.
Volutoderma mitraeformis (Gabb): STEWART, 1927:410, pl. 22, fig. 7; ANDERSON, 1958:174.
Volutomorpha mitraeformis (Gabb): JONES, SLITER & POPENOE, 1978:xxii.9, pl. 1, fig. 6 (*Volutoderma mitraeformis* on plate explanation).

Diagnosis: An almost pyriform *Carota* with about 15 axial ribs on the spire; axial ribs more numerous but reduced in strength to that of the spiral cords on body whorl.

Description: Shell medium sized, rather small for a volute; pleural angle about 65°; spire low, about ¼ the total length of the shell, with about four or five low angulately shouldered whorls; suture slightly impressed; ramp very steep, narrow, with concave band just posterior to shoulder; last whorl rounded, pyriform, with greatest diameter of whorl approximately one-third distance from suture to tip of anterior canal, and with narrow swollen subsutural band, narrow concave ramp, barely noticeable shoulder, and well-arched flank curving convexly to anterior tip of shell; last whorl of mature specimens encroaching posteriorly across preceding whorls giving a more obtuse apical angle to shell. Spiral and axial sculpture nearly equal on body whorl; spiral cords flat-topped, numbering 16 or 17 on body whorl, separated by interspaces approximately equal to cords in width; axial sculpture strongest on spire, about 16 ribs per whorl, variably developed, weaker on body whorl, strongest at shoulder; ribs about equal to cords posteriorly, diminishing anteriorly, and usually faint or absent on anterior half of whorl. Growth line with nearly straight trend perpendicular to suture but notched adjacent to suture and more deeply immediately posterior to shoulder at concave subsutural band, and having a slight retrocurrent deflection near columellar tip. Aperture elongate, ovoid with well-developed posterior groove at suture, terminating posteriorly in a narrow pointed siphonal canal; outer lip thin, smooth within, inner lip covered by a thin wash of enamel, shallowly excavated on parietal wall; columella gently flexed to the left at its tip, columellar folds three, posterior to middle of aperture, anterior and middle folds stronger and more distant, middle and posterior folds closer; no siphonal fasciole.

Holotype: MCZ cat. no. 21856.

Hypotypes: LACMIP cat. nos. 10805 (= UCLA 58445), 11617–11618 from LACMIP loc. 10789 (= CIT 1001), U.S. Highway 99, 4 miles (6.4 km) north of Redding, Shasta Co.; LACMIP cat. nos. 11573–11574 from LACMIP loc. 10769 (= CIT 1203), Dry Creek, Shasta Co., California.

Type locality: "Colusa Co., near the Hot Springs" (GABB, 1869).

Dimensions: See Table 12.

Distribution: Redding Formation, Bellavista Sandstone east of Redding, Shasta Co.; Great Valley Series near the Hot Springs, Colusa Co., California.

Geologic age: Early? Turonian, with *Tragodesmoceras*.

Remarks: Immature specimens of this species from the Redding area accord exactly with the figure and description of the holotype as given by STEWART (1927), and the Redding specimens are undoubtedly of the same species as the individual described by GABB (1869). Gabb reported this form from the "Shasta Group" (Early Cretaceous), but this age reference has been strongly questioned by STANTON (1895), STEWART (1927), and ANDERSON (1958), who considered the species to be of much younger age. Its occurrence in beds of Turonian age in the Redding area supports their opinion, and there is no evidence of its being collected from beds of Early Cretaceous age.

STANTON (1895) considered that *Carota? mitraeformis* resembled *C. dilleri* (White) from the Late Cretaceous of Redding, and STEWART (1927) suggested that Gabb's species might be an immature individual of the latter. Both species occur abundantly at Redding, but *C.? mitraeformis* is more common in the Bellavista Sandstone Member, and *C. dilleri* occurs in the Frazier Siltstone Member. *Carota? mitraeformis* differs from *C. dilleri* in greater obliquity of columellar folds, which are unequally spaced and set deeper within the aperture, lower spire, weaker shoulder, and weaker axial ribs.

Among the forms from India illustrated by STOLICZKA (1867) as *Fulgoraria elongata* and named by DALL (1907), *Carota? mitraeformis* most resembles *Rostellinda media* Dall,

1907 (STOLICZKA, 1867:pl. 7, figs. 4, 8, 9), but the illustrations of *R. media* do not indicate the presence of a posterior sinus at the shoulder, and its spiral sculpture is more widely spaced. As in the case of *C. dilleri,* the presence of the sinus in *C.? mitraeformis* suggests that it should not be assigned to *Rostellinda.* STEWART (1927) placed *C.? mitraeformis* in *Volutoderma* Gabb, 1877, but that genus also lacks the posterior sinus at the shoulder and additionally has considerably more widely spaced spiral sculpture.

Carota? mitraeformis is of smaller average size (although if complete, LACMIP cat. no. 11574 would probably be more than 50 mm high) and has a much less noticeable shoulder than species of *Carota* described by Stephenson from the Woodbine Formation of Texas. Although some adult specimens of *C.? mitraeformis* approach *Conus* in shape, *C.? mitraeformis* is more commonly shaped like a *Volutomorpha* Gabb, 1877, which lacks the posterior growth line sinus of *Carota.* The sculpture of *C.? mitraeformis* resembles that of a *Volutomorpha* of SOHL's (1964) group B and has three oblique folds on the columella, the middle one of which is slightly the stronger. However, whereas *Volutomorpha* group B species have from one to three folds that are generally not all visible in the unbroken shell, the three well-developed folds of *C.? mitraeformis* are visible, and the exterior of the shell shows no evidence of the total glaze coating that Sohl considers typical of *Volutomorpha.* All species assigned to *Volutomorpha* by Sohl are of geologically younger age than is *C.? mitraeformis*; the placement of the columellar folds and the lack of glazing and posterior growth line sinus may be evolving features, and *C.? mitraeformis* may be an early *Volutomorpha.* A more complete study of Cretaceous Volutidae is needed to clarify the generic placement of *C.? mitraeformis.*

Varens Saul & Popenoe, gen. nov.

Type species: ***Varens formosus*** Saul & Popenoe, sp. nov.

Diagnosis: Medium sized to moderately large volutes with moderately high spire; having shouldered whorls, a concave ramp, and a well-developed subsutural welt or collar, shoulder formed by posterior ends of axial ribs; last whorl broadly convex about periphery, gently concave anteriorly, tapering gracefully to a relatively long canal. Axial sculpture of ribs, pronounced and swollen at their posterior ends, diminishing anteriorly on last whorl, more strongly developed on earlier whorls, becoming shorter and knob-like on more mature whorls, diminished or obsolete on last whorl of large adults; spiral sculpture absent; exterior surface apparently coated with thin glaze. Growth lines gently retrocurrent at suture, forming a narrow posterior notch against previous whorl, nearly parallel to axis over mid whorl, gently antecurrent on siphonal neck. Aperture long and moderately narrow, outer lip thin; inner lip expanded parietally, nearly straight in columellar region; columella flexed to the left at anterior tip, bearing near base of previous whorl, three oblique spiral folds; folds progressively stronger anteriorly.

Discussion: *Rostellites gracilis* STANTON (1893:157, pl. 34, figs. 1–3) from the "*Pugnellus* sandstone" of Huerfano Park and Poison Canyon, Colorado, may belong to this genus.

No previously described volute genus shares the characteristics of three folds, the anterior strong, posterior weak, lack of spiral sculpture, and exterior apparently coated by a glaze. *Volutomorpha* Gabb, 1877 (type species *Volutolithes conradi* Gabb, 1860, from Maastrichtian of New Jersey) is exteriorly glazed but has a low to moderate spire and is sculptured by spiral ribs. Like *Rostellana* Dall, 1907 (type species *Voluta bronni* Zekeli, 1852), ***Varens*** is relatively high spired, but *Rostellana* has the shoulder less well developed and lacks a glazed coating. *Carota* is of similar shape to ***Varens*** but has a growth line that is strongly sinused at the shoulder, lacks a glazed coating, and has spiral sculpture. *Fulgoraria* Schumacher, 1817 (type species *Voluta rupestris* Gmelin, 1791, Recent from Japan) is of similar shape to ***Varens*** but has four to eight folds on the columella, apparently a larger protoconch, and is spirally grooved.

Despite its scant spiral sculpture, ***Varens*** is placed in Volutoderminae because of its shape, number of columellar folds, and growth line. It resembles genera placed in Volutilithinae Pilsbry & Olsson, 1954, but has three columellar folds rather than the one fold of Volutilithinae. PONDER & WARÉN (1988) combined these two subfamilies as Volutoderminae.

Carota? nodosa STEPHENSON, 1952 (p. 186, pl. 42, figs. 19–21) resembles ***Varens*** in shape, but it has spiral sculpture and a strong bend to the columella at the folds, and Stephenson mentions no external callus wash.

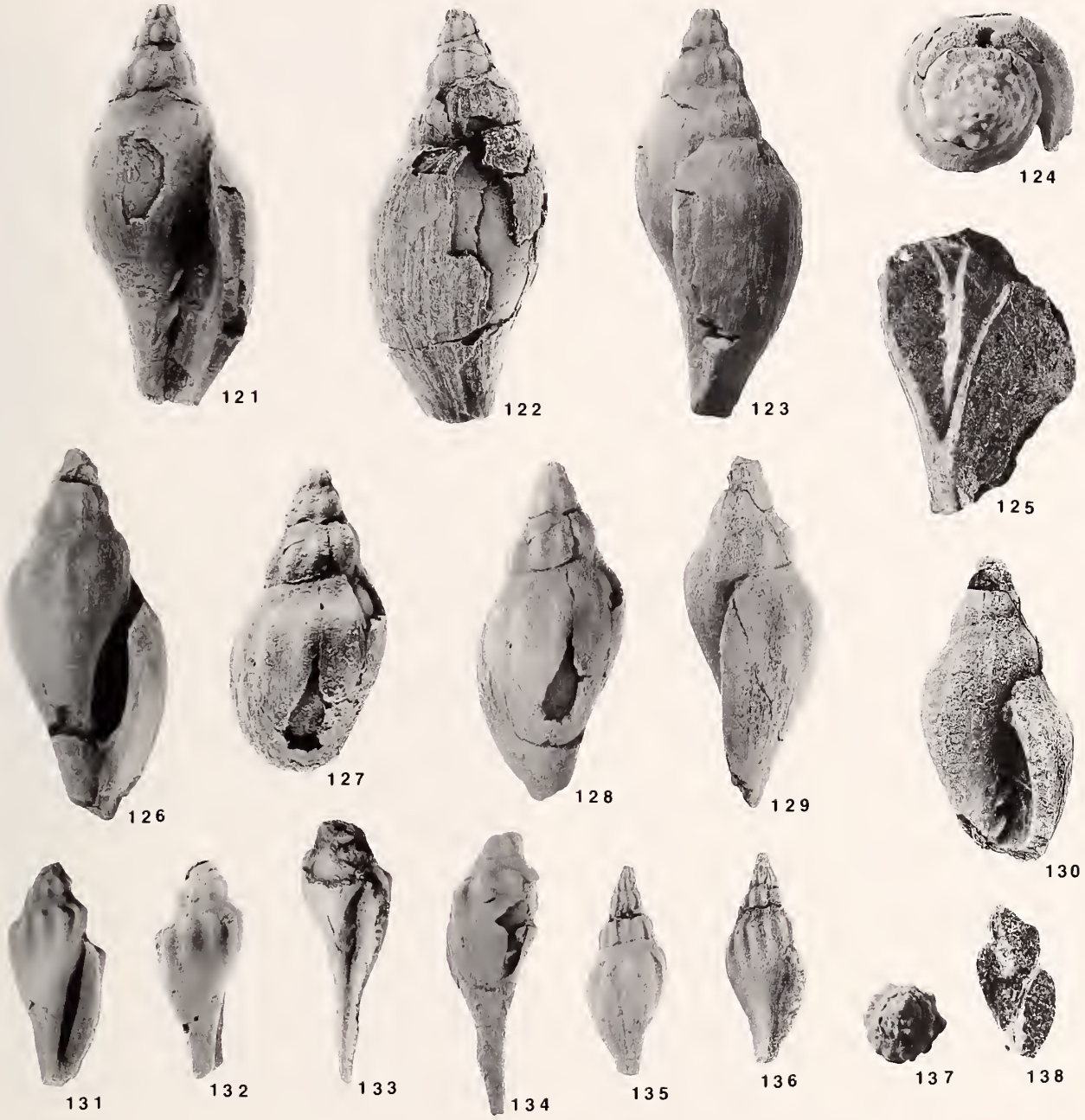
The generic name is derived from the name of a centurian in Caesar's army, Varenus, who was noted for a daring act of bravery. ***Varens*** is of masculine gender.

Varens anae Saul & Popenoe, sp. nov.

(Figures 121–130)

Diagnosis: A large ***Varens*** having about ten axial ribs per whorl on spire, with rounded flank, and obsolete sculpture on mature whorls.

Description: Shell moderately large, broadly fusiform; apical angle about 49°; protoconch unknown; spire of five or six whorls, having a well-developed, narrow, subsutural collar, and concave ramp, expanding sharply to angulate shoulder; last whorl nearly smooth, broadly convex medially, gently concave anteriorly, tapering gracefully to nearly straight anterior siphonal canal. Growth lines gently retrocurrent at suture forming a narrow V-shaped posterior notch, nearly parallel to axis medially, gently antecurrent on siphonal neck. Sculpture of about ten axial ribs, pronounced and swollen on their posterior ends, di-



Explanation of Figures 121 to 138

Unless otherwise indicated, figures are ×1; specimens coated with ammonium chloride except as noted.

Figures 121–130. ***Varens anae*** sp. nov. Figures 121–124: LACMIP cat. no. 11575 from LACMIP loc. 8195, holotype; Figure 121, aperture; Figure 122, back; Figure 123, right side; Figure 124, apical view. Figure 125: LACMIP cat. no. 11577 from LACMIP loc. 10886, paratype, section, showing columellar folds, uncoated. Figures 126–130: LACMIP cat. no. 11576 from LACMIP loc. 10886, paratype; Figure 126, aperture; Figure 127, back, anterior segment removed; Figure 128, back; Figure 129, right side; Figure 130, segment removed to show columellar folds.

Figures 131–138. ***Varens formosus*** sp. nov. Figures 131, 132: LACMIP cat. no. 11579 from LACMIP loc. 10891, holotype; Figure 131, aperture; Figure 132, left side. Figures 133, 134: LACMIP cat. no. 11580 from LACMIP loc. 10891, paratype; Figure 133, outer lip broken back, showing folds on columella and long anterior siphon; Figure 134, back. Figures 135–137: LACMIP cat. no. 11581 from LACMIP loc. 10891, paratype; Figure 135, back, ×2; Figure 136, aperture, ×2; Figure 137, apical view, ×2. Figure 138: LACMIP cat. no. 11583 from LACMIP loc. 10891, paratype, section showing columellar folds, uncoated. Photographs 121, 122, 125, 127, 130 by Susuki; 123, 124, 126, 128, 129, 131–138 by De Leon.

Table 13

Measurements (mm) of *Varens anae* sp. nov. and *Varens formosus* sp. nov.

	H	D	Hp	Dp	Ha	Hs	A	R	Dp/Hp	Hp/Hs
Varens anae										
LACMIP 11575	62.0*	27.4	8.8	18.7	22.0*	4.4	49°	10	2.1	2.0
LACMIP 11576	56.4*	24.0	9.6	15.3	18.7*	5.5	47°	12	1.6	1.7
LACMIP 11577	42.0*	—	—	—	—	—	—	—	—	—
Varens formosus										
LACMIP 11579	36.0*	16.0	7.9	10.0	12.7*	5.0	46°	11	1.3	3.6
LACMIP 11578	26.2*	11.8	7.0	9.8	11.1*	4.5	43°	12	1.4	1.5
LACMIP 11580	43.0*	11.8	—	—	—	—	—	—	—	—
LACMIP 11581	16.6*	6.8	3.5	4.8	8.0*	2.3	40°	12	1.4	1.5
LACMIP 11582	16.5*	6.4	2.0	4.3	4.6*	1.4	42°	12	2.2	1.4
LACMIP 11583	23.8	—	—	—	—	—	—	—	—	—

*Specimen incomplete. Abbreviations decrypted in Introduction.

minishing anteriorly; ribs longer, narrower, and more strongly developed on earlier whorls, becoming progressively reduced, shorter and knoblike on later whorls and diminished on penultimate whorl and obsolete on last whorl. Aperture long, pinched posteriorly, expanded medially, contracted to the anterior siphon, outer lip thin, broadly and nearly evenly convex in outline; inner lip thin, parietal portion expanded, narrow on the columella; columella with three equally spaced, very oblique folds well within the aperture; anterior fold strongest.

Holotype: LACMIP cat. no. 11575.

Paratypes: LACMIP cat. no. 11558 from UCLA loc. 2325, Silverado Canyon; LACMIP cat. nos. 11576–11577 from LACMIP loc. 10886 (= CIT loc. 84), Santiago-Trabuco divide, Santa Ana Mts., Orange Co., California.

Type locality: LACMIP loc. 8195 (= CIT loc. 82), Silverado Canyon, Santa Ana Mts., Orange Co., California.

Dimensions: See Table 13.

Distribution: Ladd Formation, Baker Canyon Sandstone, Santa Ana Mountains, Orange Co., California.

Remarks: *Varens anae* differs from *Varens formosus* in having more rounded flanks especially in mature adults, which are considerably larger than any specimen of *V. formosus*. In specimens of *V. anae* and *V. formosus* that are of equivalent size, the shoulder of *V. anae* is less pronounced, the axial ribs are not as nodular at the shoulder, and the exterior seems less glazed, although this last may be a result of preservation. *Varens anae* differs from *Carota gracilis* (Stanton, 1893) of the *Pugnellus* sandstone, near Malachite and in Poison Canyon, Huerfano Park, Colorado, in being more slender.

Etymology: The specific name refers to the occurrence of this species in the Santa Ana Mountains.

Varens formosus Saul & Popenoe, sp. nov.

(Figures 131–138)

Diagnosis: A medium-sized, elongate, angulately shouldered *Varens* with about 11 axial ribs per whorl. Surface of shell apparently coated by glaze.

Description: Shell medium sized, elongately volutiform; apical angle about 46°; spire of about five whorls, having narrow subsutural welt, concave ramp, and angulate shoulder, and nearly straight flank constricted gently about base to form a broad siphonal neck. Growth line obscured by glaze, apparently nearly parallel to axis medially, slightly antecurrent on siphonal neck. Sculpture of about 11 axial ribs, strongest at shoulder, dying out anteriorly at about mid whorl; no spiral sculpture; shell surface apparently glazed. Aperture elongate; outer lip thin; inner lip thin, narrow, rounded posteriorly; columellar folds very oblique, anterior fold strongest, posterior very weak.

Holotype: LACMIP cat. no. 11579.

Paratypes: LACMIP cat. nos. 11578 from LACMIP loc. 10946, north side Silverado Canyon at the narrows; 11580–11583 from LACMIP loc. 10891 (= CIT loc. 1065), Ladd Canyon, just north of Silverado Canyon, Santa Ana Mts., Orange Co., California.

Type locality: LACMIP loc. 10891 (= CIT loc. 1065), Ladd Canyon, Santa Ana Mts., Orange Co., California.

Dimensions: See Table 13.

Distribution: Ladd Formation, Baker Canyon Sandstone, Santa Ana Mts., Orange Co., California.

Remarks: Specimens of *Varens formosus* are noteable for their beautifully polished appearance. *Varens formosus* resembles *Carota dilleri* in shape but lacks spiral sculpture and the posterior sinus at the shoulder. *Varens formosus*

resembles young ***V. anae*** in which the bulbus adult whorls have not been formed. ***Varens formosus*** differs from ***V. anae*** in being smaller and more slender, in having a stronger shoulder, a less convex body whorl, and the posterior columellar plait barely present.

Carota? *nodosa* Stephenson, 1952, is similar in shape to ***Varens formosus,*** but ***V. formosus*** lacks spiral sculpture and has straighter axial ribs.

Etymology: The specific name is from Latin, ***formosus,*** meaning beautifully formed, comely, handsome.

Subfamily ATHLETINAE Pilsbry & Olsson, 1954

As adults, several Athletinae have a shell that becomes *Cassis*-like or strombiform. The body whorl may have a rounded or angled shoulder that may be unarmed or bear nodes or spines. The sculpture is more or less cancellate in the young, becoming partly or wholly smooth in adults.

Konistra Saul & Popenoe, gen. nov.

Type species: Gosavia biconica ANDERSON, 1958.

Diagnosis: A medium-sized, elongate pyriform volute with subsutural band, concave ramp, rounded shoulder, and rounded body whorl tapering to a broad anterior canal. Both axial and spiral sculpture present; axial sculpture strongest on early whorls, decreasing with maturity, and anteriorly over-ridden by spiral cords. Growth lines prominent, retrocurrent on subsutural band, scarcely flexed across flank. Aperture elliptical, outer lip thin; inner lip thin, expanded posteriorly; columella bearing about midway two well-developed, slightly oblique folds, flexed left and backward near its tip to form a well-developed anterior fasciole.

Discussion: Despite the number of middle Cretaceous volute genera already described, ***Konistra*** has a combination of features not found in any of them. In shape and sculpture ***Konistra*** resembles *Carota, Gosavia, Retipirula, Rostellaca, Rostellinda, Volutomorpha,* and *Volutoderma.* ***Konistra*** is most similar to *Gosavia* but has only two columellar folds, whereas *Gosavia* has five or six columellar folds and a deeply sinused growth line. ***Konistra*** tends to be shorter spired and more round shouldered than *Carota,* which has three columellar folds and a deeply sinused growth line. The sculpture of ***Konistra*** is not pustulose like that of *Retipirula,* which has two oblique folds and the trace of a third, and an anterior end to the siphon that is not strongly bent back and to the left. *Rostellaca* and *Rostellinda* are both higher spired than ***Konistra*** and have three folds on the columella. *Volutomorpha* has an overall surface glaze, a growth line that is strongly sinused adjacent to the suture, and one prominent fold on the columella rather than the two of ***Konistra***. *Volutoderma* has three oblique columellar folds and a nearly straight tip to the anterior siphon.

The generic name is derived from Greek, ***Konistra,*** a dusty rolling place. It refers to the presence of this genus at Sand Flat, Shasta Co., California, and is of feminine gender.

Konistra *biconica* (Anderson, 1958)

(Figures 114–120)

Gosavia biconica ANDERSON, 1958:175, pl. 75, figs. 3, 3a.

Description: Shell medium sized; pleural angle about 66°; spire low, about one-fifth the total length of the shell, with about five or six low angulately shouldered whorls; suture at or covering shoulder; ramp broad and shallowly sloping; last whorl pyriform, with greatest diameter of whorl just anterior to shoulder and approximately one-fourth the distance from suture to tip of anterior canal, with a relatively broad flat ramp, a subangulate shoulder, and well-arched flank curving convexly to constricted anterior siphonal neck; neck angled backward and to the left near its tip. Rough spiral and axial sculpture on body whorl; spiral cords unevenly spaced, numbering about 20 on body whorl, separated by interspaces of somewhat variable width but approximately equal to cord width; axial sculpture strongest on spire and at shoulder; ribs stronger than cords on fifth whorl, progressively weaker on subsequent whorls, about equal to cords posteriorly, diminishing anteriorly, usually faint or absent on anterior half of whorl, about 12 on fifth whorl, 10 on sixth, variably developed, weakest on body whorl. Growth lines prominent, with nearly straight trend perpendicular to suture but notched adjacent to suture and having a strong bend at anterior fasciole. Aperture elongate, ovoid with well-developed posterior groove at suture; outer lip thin, smooth within; inner lip expanded roundly onto body whorl, commonly encroaching above shoulder and exposed as a frill adjacent to suture; columella flexed backward and to the left near its tip; columellar folds two, just posterior to middle of aperture; siphonal fasciole moderately developed.

Holotype: CASG cat. no 61935.01.

Hypotype: LACMIP cat. no. 11619 from LACMIP loc. 10789 (= CIT 1001), sec. 7, T32N, R4W, Redding (1946) quadrangle, Shasta Co., Caldifornia.

Type locality: CASG loc. 61935 [*ex* CASG 1294-A], "near the State highway, on Sand Flat," north of Redding, Shasta Co., California.

Dimensions: See Table 14.

Distribution: Known only from the vicinity of "Sand Flat." On 1913 U.S.G.S. Redding 30′ Quadrangle, Sand Flat is between Buckeye and Salt creeks along U.S. highway 99, but is not designated on 1946 Redding 15′ Quadrangle.

Geologic age: Turonian.

Remarks: In overall shape and sculpture ***Konistra*** *biconica*

Table 14

Measurements (mm) of **Konistra** *biconica* (Anderson, 1958).

	H	D	Hp	Dp	Ha	Hs	A	Dp/Hp	Hp/Hs
CAS 61935.01	43.7*	8.4	3.4	16.7	9.7	2.0	66°	4.9	1.7
LACMIP 11619	49.0*	21.4	5.2	5.0	6.9*	1.8	75°	0.97	2.9

* Specimen incomplete. Abbreviations decrypted in Introduction.

does resemble a *Gosavia,* but ***K.*** *biconica* has only two columellar folds rather than the five or six of *Gosavia* and lacks the growth line sinus present at the shoulder of *Gosavia squamosa* (Zekeli, 1852). ***Konistra*** *biconica* is superficially so similar to *Carota? mitraeformis* that the two are commonly mixed in collections, but ***K.*** *biconica* has one less fold on the columella, weaker sculpture, a nearly straight growth line, and a better developed anterior fasciole.

The specimen, CASG cat. no. 1552.03, referred to *Palaeatractus crassus* by ANDERSON (1958:42) has two columellar folds and resembles ***Konistra*** *biconica* except that the shoulder is well rounded and without angularity. Unfortunately the anterior end is broken and the shape of the anterior canal unknown. Specimen CASG cat. no. 1552.03 occurs with ammonites considered by MATSUMOTO (1960: 80) to suggest late Campanian or early Maastrichtian age. The specimen is considerably larger than any other referred to *P. crassus.*

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CIT and UCLA localities have been given LACMIP numbers. Most of the CIT localities of Turonian age in the Redding area were plotted on JONES *et al.* (1978:fig. 5). Most of the CIT localities of the northern Santa Ana Mountains were plotted on POPENOE (1942:fig. 2); these and UCLA localities were plotted on SAUL & BOTTJER (1982:maps 1–3). Many of the localities discussed in MATSUMOTO (1960) are also plotted therein.

Frazier Corners was almost a mile (1.6 km) northwest of Bella Vista on the Redding (30′) quadrangle, 1901 edition, reprinted 1913 and 1928, and also on the Shasta National Forest, California map of 1948. The Frazier Siltstone Member derives its name from Frazier Corners (HAGGART, 1986), and it serves as a reference point in several locality descriptions. However, on the Millville (15′) quadrangle, 1953, and the Bella Vista (7.5′) quadrangle, 1965, Bella Vista has been moved and replaces Frazier Corners.

82 CIT: = LACMIP 8195.

84 CIT: = LACMIP 10886.

92 CIT: = LACMIP 10100.

445 CASG: Fossils from Forty-nine mine, 2 miles (3.2 km) south of Phoenix, Jackson Co., Oregon. Hornbrook Formation. Late Turonian. (MATSUMOTO, 1960:77).

1001 CIT: = LACMIP 10789.

1032 CIT: = LACMIP 10726.

1042 CIT: = LACMIP 10876.

1065 CIT: = LACMIP 10891.

1164 CIT: = LACMIP 10079.

1195 CIT: (= UCLA 4416; LACMIP 10778) In bed of Stinking Creek, about midway between two north–south wire fences across creek, 2600′N, 1100′E of SE cor. sec. 6, T32N, R3W, Redding (1946) Quadrangle, Shasta Co., California. Coll.: Popenoe and Ahlroth, 21 June 1936. Redding Formation, Bellavista Sandstone Member. Early Turonian. (MATSUMOTO, 1960:104; POPENOE *et al.*, 1987:99).

1197 CIT: (= LACMIP 10776) Block of sandstone crowded with *Pugnellus manubriatus* picked up from stream bed of Stinking Creek, just downstream from first fence across creek upstream from the creek mouth, 4050′N, 44°W of SE cor. [2250′S, 2000′E of NW cor.] sec. 6, T32N, R3W, Redding (1946) Quadrangle, Shasta Co., California. Coll.: Popenoe & Ahlroth, 21 June 1936. Redding Formation, Bellavista Sandstone Member. Turonian. (JONES *et al.*, 1978:fig.5).

1203 CIT: (= LACMIP 10769) lens in sandstone cropping out in bed of Dry Creek, 700′S, 300′W of NE cor. sec. 6, T32N, R3W, Millville Quadrangle, Shasta Co., California. Coll.: Popenoe and Ahlroth, 23 June 1936. Redding Formation, near middle of Bellavista Sandstone Member. Turonian.

1207 CIT: = LACMIP 10810.

1209 CIT: = LACMIP 10771.

1212 CIT: (= LACMIP 10735) Little Cow Creek, Millville Quadrangle, Shasta Co., California.

1255 CIT: (= LACMIP 10744) French Creek north of Swede Basin.

1264 CIT: (= LACMIP 10759) Massive brown sandstone cropping out in bed of small gully tributary

to Little Cow Creek, approx. 1805'S, 2250'E of NW cor. sec. 9, T32N, R3W, Millville Quadrangle, Shasta Co., California. Coll.: W. P. Popenoe, 12 April 1937. Redding Formation, base of Melton Sandstone Member. Turonian. (MATSUMOTO, 1960:105).

1293D CASG: = CASG 61934.

1346 CIT: = LACMIP 10754.

1438 CIT: Highest sandstone bed under lava in gully on N side of Little Cow Creek, about ¼ mile (0.4 km) NE of Wilsey Ranch House, near NE cor. SW ¼ sec. 31, T33N, R2W, Millville Quadrangle, Shasta Co., California. Coll.: W. P. Popenoe, 19 March 1940. Redding Formation, Bellavista Sandstone Member. Turonian.

1446 CIT: (= LACMIP 10764) Near top of N slope of hillside SE of Alturas-Redding Hwy, S side Woodman Creek, 2250'S, 500'W of NE cor. sec. 35, T33N, R3W, Millville Quadrangle, Shasta Co., California. Coll.: W. P. Popenoe, 23 March 1940. Redding Formation, Bellavista Sandstone Member. Turonian. (POPENOE *et al.*, 1987:99).

1552 CASG: South side of Antelope Valley, north end of Shale Hills, 500'W of center sec. 28, T26S, R18E, Kern Co., California. Coll.: G. D. Hanna and S. H. Shaw, April 1929. Panoche Formation. Late Campanian-early Maastrichtian. (MATSUMOTO, 1960:80).

1622 CIT: = LACMIP 10903.

2209 UCBMP: ?Sucia Island, San Juan Co., Washington. Cedar District Formation. Campanian.

2325 UCLA: Small gully entering Silverado Canyon from S, just W of the narrows, directly S of Holz Ranch house, about 1025'N, 150'E of SW cor. sec. 8, T5S, R7W, El Toro Quadrangle, Santa Ana Mts., Orange Co., California. Coll.: W. P. Popenoe, 1946. Ladd Formation, top of Baker Canyon Sandstone. Turonian.

2360 CASG: "Devils Gate" on Berryessa Creek, 12,000 feet (3700 m) below top of Chico Group on Hamilton Ranch, near top of big conglomerate, Napa Co.?, California. Possibly Venado Formation. Turonian.

2757 USGS: Silverado Canyon, near mouth of Ladd Canyon, Santa Ana Mts., Orange Co., California. Coll.: S. Bowers, 23 April 1903. Ladd Formation, upper Baker Canyon Sandstone Member. Turonian.

2759 USGS: Near Silverado Canyon, in lower part of Ladd Canyon, Santa Ana Mts., Orange Co., California. Coll.: S. Bowers, 24 April 1903. Ladd Formation, upper Baker Canyon Sandstone Member. Turonian.

4214 UCLA: Soft thin-bedded sandstone exposed in channel of Little Cow Creek, SE cor. sec. 35, T33N, R3W, Millville Quadrangle, Shasta Co., California. Coll.: W. P. Popenoe, 2 September 1959. Redding Formation, Frazier Siltstone Member. Turonian.

4235 UCLA: Dip slope of Baker Canyon Sandstone on Black Star Quadrangle, cropping out about 0.3 mile (0.5 km) NW of old Holz Ranch house, 2600'N, 700'W of SE cor. sec. 7, T5S, R7W, El Toro Quadrangle, Santa Ana Mts., Orange Co., California. Ladd Formation, Baker Canyon Sandstone Member. Late Turonian.

4252 UCLA: Banks of irrigation ditch at about 2450 foot (750 m) elev., W of and above SP RR tracks, W side of Bear Creek Valley, 2.8 mile (4.5 km) SE of Normal School Campus at Ashland, approx. 3100'N, 500'E of SW cor. sec. 24, T39S, R1E, Ashland Quadrangle, Jackson Co., Oregon. Coll.: W. P. Popenoe, 19 May 1944. Hornbrook Formation. Turonian.

5422 UCLA: Rancheria Gulch, about 1 mile (1.6 km) W of Henley, and approx. 400'N, 2000'W of SE cor. sec. 19, T47N, R6W, Yreka 30' Quadrangle (1939), Siskiyou Co., California. Coll.: W. P. Popenoe, summer 1951. Hornbrook Formation, Osburger Gulch Member. Turonian.

7199 UCLA: between Fremont Canyon and Oak Flat along a south fork of Fremont Canyon at about 1860 foot (570 m) elev., 350'N, 1050'E of SW cor. sec. 7, T4S, R7W, Black Star Canyon Quadrangle, northern Santa Ana Mts., Orange Co., California. Coll.: W. P. Popenoe and J. E. Schoelhammer, 28 November 1952. Willams Formation, Pleasants Sandstone Member. Campanian.

7233 UCLA: Sulphur Creek, hard sandstone about 500 feet (150 m) upstream from abandoned cabin on east side of creek, NE ¼, SW ¼ (2500'N, 1750'E of SW cor.) sec. 23, T32N, R5W, Redding Quadrangle (1946), Shasta Co., California. Coll.: P. U. Rodda, summer 1956. Redding Formation, Bellavista Sandstone Member. Turonian.

7787 UCR: South side Silverado Canyon, elev. approx. 1340 feet (400 m), stream drainage directly below UCR loc. 7785, SW ¼, SW ¼ sec. 8, T5S, R7W, El Toro Quadrangle (1949), Santa Ana Mts., Orange Co., California. Coll.: Geol. 110 class, 8 November 1975. Ladd Formation, lower Holz Shale. Turonian.

7788 UCR: South side Silverado Canyon, elev. approx. 1370 feet (420 m), concretions in next stream drainage to south of UCR 7787 that leads to Silverado Creek, SW ¼, SW ¼ sec. 8, T5S, R7W, El Toro Quadrangle (1949), Santa Ana Mts., Orange Co., California. Coll.: Geol. 110 class, 8 November 1975. Ladd Formation, lower Holz Shale. Turonian.

8195 LACMIP: (= CIT 82) Limey sandstone bed near base of shale, S of roadcut at Holz Ranch

(locality may become obscured by slides), Silverado Canyon [E edge SE ¼, SE ¼ sec. 7, T5S, R7W, El Toro Quadrangle], Santa Ana Mts., Orange Co., California. Coll.: B. N. Moore, 1927. Ladd Formation, Holz-Baker Canyon transition. Turonian.

10079 LACMIP: (= CIT 1164) S side Silverado Canyon near mouth of small N-flowing gully, and at top of lower fossiliferous sandstone series, about 400 feet (120 m) SE of Holz Ranch house in SE cor. sec. 7, T5S, R7W [1025'N, 150'E of SW cor. sec. 8], T5S, R7W, El Toro Quadrangle, Santa Ana Mts., Orange Co., California. Coll.: W. P. Popenoe, 15 May 1935. Ladd Formation, Baker Canyon Sandstone Member. Turonian.

10100 LACMIP: (= CIT 92) Concretions in shale 100 feet (30 m) above stream and near fence on N side of Harding canyon, about ¼ mile (0.4 km) N of road fork in Santiago Canyon at Modjeska Canyon junction [near section line NW ¼, NW ¼ sec. 28, T5S, R7W, Santiago Peak Quadrangle] Santa Ana Mts., Orange Co., California. Coll.: B. N. Moore, 1928. Ladd Formation, basal Holz Shale Member. Turonian.

10726 LACMIP: (= CIT 1032) Shale outcrop on left bank of Dry Creek, E of road, 1.3 mile (2 km) N of Frazier's Corners, 1500'N of SE corner sec. 5, T32N, R3W, Millville Quadrangle, Shasta Co., California. Coll.: W. P. Popenoe, 1933. Redding Formation, Frazier Silt. Turonian.

10735 LACMIP: (= CIT 1212) Little Cow Creek, approx. 2 mile (3.2 km) NE of Frazier's Corners, hard sandy concretions in shale, banks of gullies in pasture about 2500'N, 750'W of SE cor. sec. 4, T32N, R3W, Millville Quadrangle, Shasta Co., California. Coll.: Popenoe and Ahlroth, 7 July 1936. Redding Formation, Frazier Siltstone Member. Turonian. Jones *et al.* (1978:fig. 5).

10744 LACMIP: (= CIT 1255) W bank French Creek about ½ mile (0.8 km) N of Swede Basin, 600'N, 600'E of SW cor. sec. 33, T33N, R2W, Millville Quadrangle, Shasta Co., California. Coll.: W. P. Popenoe, 12 April 1937. Redding Formation, Bellavista Sandstone Member. Turonian.

10754 LACMIP: (= CIT 1346) Sandstone nodules in shale, left bank of Little Cow Creek, about 75 yards (70 m) NE (upstream) from intersection of creek bed with S line of sec. 9, and about ¼ mile (0.4 km) downstream from Walter Melton farmhouse, 10 mile (16 km) NE of Redding, 1500'N, 2200'E of SE cor. sec. 9, T32N, R3W, Millville Quadrangle, Shasta Co., California. Coll.: W. P. Popenoe and Jane Hoel, 8 July 1937. Redding Formation, Melton Sandstone Member. Turonian.

10771 LACMIP: (= CIT 1209) Oyster bed on left bank Salt Creek, about ½ mile (0.8 km) N of gravel pits N of Alturas-Redding Hwy (U.S. 299), 1650'S, 1200'W of NE cor. sec. 34, T33N, R3W, Millville Quadrangle, Shasta Co., California. Coll.: Popenoe and Ahlroth, 27 June 1936. Redding Formation, Bellavista Sandstone Member. Turonian.

10789 LACMIP: (= CIT 1001) West side of U.S. 99, 4.0 mile (6.4 km) by road N of Hwy 99 bridge just N of Redding over Sacramento River, sec. 7, T32N, R4W, Redding (1946) Quadrangle, Shasta Co., California. Coll.: W. P. Popenoe and D. W. Scharf, 15 July 1931. Redding Formation, Bellavista Sandstone Member. Turonian.

10810 LACMIP: (= CIT 1207) Right side of Dry Creek, at Bellavista-Sherman Rd. crossing and 2.3 road miles (3.7 km) N of Redding-Alturas Hwy (U.S. 299) 2700'N, 50'W of SE cor. sec. 31, T33N, R3W, Millville Quadrangle, Shasta Co., California. Coll.: Popenoe and Ahlroth, 26 June 1936. Redding Formation, Bellavista Sandstone Member. Turonian.

10876 LACMIP: (= CIT 1042) Limey lenses in sandstone cropping out on N bank of Rancheria Gulch, about 1.5 mile (2.4 km) W of Henley, 210'S, 800'E of NW cor. sec. 30, T47N, R6W, Hornbrook Quadrangle, Siskiyou Co., California. Coll.: Popenoe and Findlay, 8 September 1933. Hornbrook Formation, Osburger Gulch Sandstone Member. Turonian.

10886 LACMIP: (= CIT 84) Sandstone above basal conglomerate. SW cor. of NE ¼ sec. 34, T5S, R7W, Santiago-Trabuco divide, Santa Ana Mts., Orange Co., California. Coll.: B. N. Moore, 1926. Ladd Formation, Baker Canyon Sandstone Member. Turonian.

10891 LACMIP: (= CIT 1065) Sandstone overlying basal Upper K conglomerate, from crest of scarp on W side of Ladd Canyon, about 0.6 mile (1 km) N of juncture of Ladd and Silverado canyons [1300'S, 300'E of NW cor. sec. 8, T5S, R7W, Black Star Canyon Quadrangle], Santa Ana Mts., Orange Co., California. Coll.: W. P. Popenoe, 3 March 1933. Ladd Formation, Baker Canyon Sandstone Member. Turonian.

10903 LACMIP (= CIT 1622): Soft gray sandstones cropping out along irrigation ditch 150–200 feet (46–61 m) above and to SW of Southern Pacific RR tracks about 4.0 mile (6.4 km) SE of U.S. Hwy 99 bridge over Ashland Creek, near midpoint of W boundary sec. 24, T39S, R1E, Ashland Quadrangle, Ashland, Jackson Co., Oregon. Coll.: W. P. Popenoe and W. A. Findley, 12 September 1933. Hornbrook Formation, Osburger Gulch Sandstone Member. Turonian.

15295 LACMIP: South side of Silverado Canyon near mouth of small N-flowing gully, about 400 feet

(120 m) SE of Holz ranch house, 1025′N, 150′E of SW cor. sec. 8, T5S, R7W, El Toro Quadrangle, Santa Ana Mts., Orange Co., California. Coll.: Robert Drachuk, 1979. Ladd Formation, top of Baker Canyon Sandstone Member. Turonian.

61934 CASG: (= CASG 1293D) Near Frazier Corners, SW ¼ sec. 4, T32N R3W, Millville Quadrangle, Shasta Co., California. Coll.: C. M. Cross. Redding Formation, Frazier Siltstone Member. Turonian.

61935 CASG: (= CASG 1294-A): 4.6 miles (7.4 km) north of bridge at Redding, near the State highway, on "Sand Flat," Shasta Co., California. Coll.: F. M. Anderson. Redding Formation, Bellavista Sandstone Member. Turonian.

66549 CASG: Hagerdorn Ranch, 4 mile (6.4 km) NW of Montague, Siskiyou Co., California. Hornbrook Formation, probably Osburger Gulch Sandstone Member. Turonian.

85511 GSC: Hamley Point, Sydney Island, lat. 48°36′05″N, long. 123°16′05″W, British Columbia. Coll.: J. E. Muller, 21 August 1970. Nanaimo Group, near base. Turonian. (POPENOE *et al.*, 1987:100).